

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section D BOTANY

Bull. Res. Counc. of Israel. D. Bot.

Continuing the activities of the
Palestine Journal of Botany,
Jerusalem and Rehovot Series

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A FURTHER CONTRIBUTION TO THE BRYOPHYTIC FLORA OF PALESTINE

F. BILEWSKY

Ramat Gan

ABSTRACT

A second annotated list comprising 95 mosses is given. Four mosses: *Didymodon spadiceus* Limpr., *Crossidium griseum* Jur., *Bryum canariense* Schpr. and *Zygodon viridissimus* (Dicks.) R. Brown var. *vulgaris* Malta are recorded for the first time from Palestine, the last apparently being new to the Eastern Mediterranean.

The following enumeration of Palestine mosses is prepared from previous work (see references) and from new findings and determinations.

FISSIDENTALES

Fissidens bambergi Schpr.

Sh*: Yarkon bridge, Abu Kakhwa, on earth with *Tortula marginata*, *Tortula muralis* and *Fossombronina* sp., II.1957 B.; EV: near Ein Harod, 1927; J: near Jerusalem, 1927, both Rab.

Fissidens bryoides (L.) Hedw.

Ca: 1927 Rab.

Fissidens impar Mitt.

Ca: Wadi Falah, III.1954 N.; Sh: Yarkon bridge, Herzliya, single or mixed up with *Bryum*, *Barbula* sp. and *Dicranella varia*, X.1956 B.; LG: Sartaba- Nazareth, on stones, III.1944 K.; J: near Jerusalem, I.1941 K.

Fissidens mnevidis Ammann.

LG: Kefar Hakhosh, on stones, II.1944 K.; J: near Jerusalem, small cave, I.1943 DZ.

Fissidens bilewskyi Pot. d.l. V. in Rev. bryol. 25, 1-2, 1956.

Sh: Ramat Gan, Napoleon's hill, on earth, II.1952 Fr.

*ABBREVIATIONS

Districts: A—Acre Plain, Ca—Mt. Carmel, CN—Central Negev, EV—Esdraelon Valley, J—Judean Mountains, JD—Judean Desert, L—Lebanon, LG—Lower Galilee, LJ—Lower Jordan Valley, NN—Northern Negev, P—Philistaeon Plain, S—Shomron (Samaria), Sh—Sharon, SN—Southern Negev (Eilat with surroundings), UG—Upper Galilee, UJ—Upper Jordan Valley.

Collectors: B—F. Bilewsky, B-jun.—J. Bilewsky, Fr.—Y. Friedberg, Gā—L. Galil, K—T. Kushnir, L—N. Landau, N—Shoshana Nachmony, Rab—Debora Rabinowitz-Sereni, DZ—D. Zohary.

Received September 15, 1958.

Fissidens minutulus Sull.

EV: Givat Hamore, with *Weisia* sp. and *Tortula muralis*, II.1955 B.; J: near Jerusalem, II.1943 DZ.; ibidem: near Beit Govrin, inside dark limestone cave, II.1956 B.

DICRANALES

Dicranella varia Schpr. (= *Anisothecium rubrum* (Huds.) Lindb.)

Sh: Yarkon bridge, Herzliya, X.1956 B.

POTTIALES

Encalypta vulgaris (Hedw.) Hoffm.

J: Nes Harim, from limestone, woodland, III.1959 B.

Hymenostomum tortile (Schwaegr.) Br.Eur.

Ca: Tel Hanan, Wadi, s. d. *Ga.*; Sh: Yarkon bridge, Herzliya, on earth, X.1956 B.; UG: Wadi Qarn, X.1956 B.; J: Qiriyat Anavim, on stones, V.1956 B.; UJ: Ein Gev, III.1944 K.

Gymnostomum calcareum N. et H.

Sh: north of Apollonia ruins, small brook on the sea shore, VIII.1956 B.; J: Beit Govrin, inside limestone cave, II.1956 B.; CN: near Avdat, opposite the caves, IV.1956 B.; SN: Ein Netaphim, on wet rock, IV.1956 B.; JD: Wadi Tse'elim, on wet sand B.

Gymnostomum calcareum var. *brevifolium* Schpr.

Sh: Ramat Gan, rocky entrance to cave, 1932 B.

Gymnostomum rupestre Schleich.

LJ: near Jericho, s.d., *Hart*.

Gyroweisia tenuis (Schrad.) Schpr.

CN: Makhtesh Hagadol, on earth, sterile, III.1956 B.

Leptobarbula berica (DeNot.) Schpr.

Ca: Wadi west of Ahuza, on limestone, with *Tortella nitida*, II.1955 B.

Eucladium verticillatum (L.) Br.Eur.

Sh: Miqve Israel, with *Hydrogonium ehrenbergii*, XII.1956 B.; UG: Wadi Limun, from stone and from earth, V.1956 B.; J: Mevuot Betar, near the springs, IV.1957 B.

Tortella flavovirens (Bruch.) Broth.

Ca: near Ahuza, on rocks, II.1955 B.; EV: Givat Hamore, II.1955 B.; J: Shaar Hagai, X.1952 B.

Tortella nitida (Lindb.) Broth.

A: near Nahariya, inside cave, II.1953 B.

Tortella inflexa (Bruch. Broth.

Ca: Ya'arot Hacarmel, XI.1955 B.; Sh: Benei Beraq, s.d. B.; LG: Oranim, on small stones, X.1956 B.; She: Ben Shemen, rocky woodland, with *Bryum* sp., II.1955 B.

Timmiella barbuloidea Br. Eur.

Sh: Yarkon bridge, Herzliya, on earth, X.1956 B.; EV: Mayan Harod, I.1957 B.; UG: Wadi Limun, on stones, V.1956 B.; ibidem, Tel el Safi, X.1958 B.; J: near Nes Harim, IV.1957 B.

Timmiella anomala (Br.Eur.) Limpr.

Ca: no special place given.; J: near Jerusalem, both s.d. *Rab.*

Trichostomum brachydontium Bruch.

J: Shaar Hagai, with *Fissidens* sp., X.1952 *B.*

Trichostomum pallidisetum H.M.

UG: Wadi Qarqara, with *Scorpiurium circinnatum*, III.1953 *B.*; EV: Tel el Safi, X.1958 *B.*

Didymodon tophaceus Jur.

Sh: Ramat Gan, house wall, with 5 other moss species, XI.1952 *B.*; CN: Makhtesh Hagadol, IV.1956 *B.*; ibidem: Wadi Muraphi, cascades, IV.1956 *B.*; ibidem: Avdat, on earth, III.1956 *B.*; SN: Ein Netaphim, submerged and in rock fissures, dried up, IV.1956 *B.-jun.*; JD: Wadi Tse'elim, III.1957 *B.-jun.*; UJ: Hagoshrim, on dry place, between oaks, with *Aloina* sp. and *Barbula* sp., IV.1952 *B.*

Didymodon luridus Hornsch.

J: Jerusalem, s.d. *Reichert*; CN: Makhtesh Hagadol, on earth, mixed up with *Aloina rigida* and *Barbula vinealis*, III.1956 *B.*; JD: Wadi Tse'elim, together with *Funaria mediterranea*, III.1957 *B.*; ibidem: Massada, summit, on dried up cistern well, III.1957 *B.-jun.*

Didymodon spadiceus Limpr.

Sh: Yarkon bridge, Herzliya, II.1957 *B.*; UG: Wadi Tabahin, near cascades, with *Funaria convexa* and *Hydrogonium ehrenbergii*, V.1956 *B.*; J: Mevuot Betar, on earth, between many small springs, IV.1957 *B.*; JD: Wadi Zohar, on earth, between rocks, XII.1958 *B.*

Hydrogonium ehrenbergii (Lor.) Fl.

Ca: Wadi Tel Hanan, s. d., *Gal.*; UG: Wadi Tabahin, near cascades, with *Didymodon spadiceus*, V.1956 *B.*; ibidem: Wadi Hindaj, IV.1954 *B.*; EV: Mishmar Ha'emek, III.1958 *B.*; CN: Wadi Muraphi, cascades, IV.1956 *B.*

Barbula vinealis Brid.

Ca: Ya'arot Hacarmel, with *Bryum donianum* and *Fissidens impar*, XI.1955 *B.*; P: Zikkim, ruins in orchard, II.1956 *B.*; EV: Givat Hamore, with *Tortella flavovirens*, II.1955 *B.*; J: Beit Govrin-Maresha, entrance to limestone cave, together with *Fossombronina caespitiformis*, *Fissidens* sp. *Timmiella barbuloidea* and *Funaria* sp., II.1956 *B.*; CN: Makhtesh Hagadol, on earth, IV.1956 *B.*; LJ: near Jericho, s. d., *Hart.*

Barbula cylindrica (Tayl.) Schpr.

P: near Ashqelon, IV.1954 *B.*; J: Beit Shemesh, II.1956 *B.*

Barbula acuta Brid.

Sh: Ma'abarot, on earth, with *Tortula cuneifolia*, VI.1954 *B.*; ibidem: Yarkon bridge, Herzliya, "10 mills," on earth, with *Timmiella barbuloidea*, X.1956 *B.*; UG: Mala'ha, Hula, on rocks, III.1953 *B.*; CN: Wadi Muraphi, from rocks, in bad state, no certain determination, IV.1957 *B.-jun.*

Barbula hornschi Schultz.

A: Nahariya, IV.1954 *B.*; She: Ben Shemen, woodland, I.1955 *B.*; UJ: Hagoshrim, dry place between oaks, with *Aloina* sp. and *Barbula* sp., IV, 1952 *B.*

Barbula revoluta Brid.

UG: Wadi Qarn, on rocks, IV.1954 *B.*; J: Jerusalem, s. d., *Reichert*; ibidem: Qiriyat Anavim, on rocks, with earth, V.1956 *B.*

***Barbula fallax* Hedw.**

JD: Wadi Tse'elim, on wet siliceous ground, IV.1957 *B-jun*.

***Barbula convoluta* Hedw.**

UG: Mt. Jarmaq, summit, with *Barbula fallax*, *Encalypta vulgaris* and *Grimmia pulvinata*, IV.1954 *B*.

***Barbula unguiculata* Hedw.**

A: near Nahariya, inside cave, III.1953 *B*; UG: Wadi Qarn, from wet place, IV.1954 *B*; EV: Tel el Safi, IX.1958 *B*; J: Shaar Hagai, X.1952 *B*; ibidem: near Hebron, s.d., *Hart*; JD: Ein Gedi, near David's spring, X.1957 *B*.

***Aloina ambigua* (B. et S.) Limpr.**

Sh: Tel-Aviv, house garden, I.1953 *B*; S: Megiddo, ruins, with *Pottia* sp. and *Fossombronina* sp., II.1957 *B*; UJ: Ein Gev, III.1944 *K*; ibidem: Hagoshrim, IV.1952 *B*; JD: Wadi Tse'elim, I.1957 *B-jun*.

***Aloina aloides* (Schultz) Kindb.**

Ca: above Nesher, II.1956 *B*; P: near Gaza, s.d., *Hart*; JD: Massada summit, on dry place, between stones, together with *Crossidium griseum*; ibidem: Wadi Tse'elim, on stones, with *Funaria mediterranea* and *Tortula muralis*, both III. 1957 *B-jun*.

***Aloina rigida* (Hedw.) Kindb.**

Sh: Ramat Gan, house-wall at "Seven mills," II.1953 *B*; CN: Makhtesh Hagadol, III.1956 *B*; ibidem: Subeita, old terraces in Wadi, on earth, I.1958 *B*.

***Aloina rigida* var. *pilifera* Moenkem.**

P: near Gaza, s. d., *Hart*; J: Jerusalem, near St. Luke's, s. d., *Reichert*; CN: Qurnub, on earth, with *Barbula fallax*, III.1956 *B*; ibidem: Makhtesh Hagadol, III.1956 *B*; ibidem: Mizpe Ramon, inside hole in rock, together with *Bryum* (probably *caespitium*), *Tortula muralis* and *Gymnostomum calcareum*, IV.1959 *B*; JD: Wadi Tse'elim, II.1957 *B*.

***Tortula marginata* (Br.Eur.) Schpr.**

Sh: Miqve Israel, wall of old cistern, with *Eucladium verticillatum*, XII.1956 *B*; UG: Mt. Jarmaq, II.1954 *B*; ibidem: Hazor near Ayelet, III.1953 *B*; ibidem: Mt. Kena'an, Kaba'a springs, IV.1954 *B*; LG: near Nazareth, s. d., *B*; EV: Givat Hamore and Mayan Harod, both II.1955 *B*; S: Wadi Ara, on stones, with *Barbula fallax* and *Bryum* sp., IV.1954 *B*. UJ: Tel el Qadi, on tombstone, with *Barbula acuta*, *Tortula muralis* and *Bryum* sp. IV.1954 *B*.

***Tortula subulata* (L.) Hedw.**

J: near Hebron, s. d. *Hart*; JD: Ein Gedi, near David's spring, IV.1957 *B*.

***Tortula atrovirens* (Sw.) Lindb.**

CN: Qurnub, on earth and on stones, with *Aloina rigida pilifera*, III.1956 *B*; JD: Ein Gedi, cascades of David's spring, partly submerged, III.1957 *B*; ibidem: Wadi Massada, XII.1958 *B*.

***Tortula cuneifolia* (Dicks.) Roth.**

CN: near Subeita, on roof of old cistern, in bad state, not certain, IV.1956 *B*; JD: Wadi Tse'elim III.1957, not certain determination, *B*.

***Tortula brevissima* Schiffn.**

J: Mt. Scopus, Jerusalem, Hebrew University gardens, VII.1955 *Klonner*.

***Tortula inermis* (Brid.) Mont.**

J: Jerusalem, X.1952 *B*.

Tortula ruralis (L.) Ehrh.

UG: Mt. Szabalan near Hurfeish, maquis, IV.1954 B.

Tortula muralis Hedw.

In all parts of the country, from P: Zikkim, IV.1955 B; CN: Mizpe Ramon, IV.1959 B and JD: Massada, summit, III.1957 *B-jun.*, to the extreme north.

Tortula muralis var. aestiva Brid.

J: Qiriyat Anavim, Park Cilla, form near the variety, V.1956 B.; ibidem: Hebron and Jerusalem, both s. d., *Hart*.

Tortula muralis var. israelis Biz. et. Bil.

The name had to be changed as the characteristics are sufficient only for a variety. J: Qiriyat Anavim, roof of old cistern, V.1956 B.

Tortula muralis var. obcordata Schpr.

Ca: near Wizo school, on rocks, VI.1956, B.

Tortula canescens (Bruch) Mont.

EV: Mt. Tabor, ruins, with *Timmiella barbuloidea*, X.1956 B.; CN: Wadi Muraphi-Wadi Tsin, on stony ground, probably, in bad state, IV, 1956 B.

Tortula vahliana (Schultz) DeNot.

J: Jerusalem, the valley of the Cross, I.1943 K.

Tortula laevipila Brid.

J: Bethlehem, s. d., *Hart* (n.v.).

Phascum cuspidatum Schr. var. piliferum H. et T.

LG: Balfour Forest, IV.1937 L.; EV: Heftsi Ba, II, 1944 K.; J: Mt. Scopus, Jerusalem, Hebrew University gardens, VII.1955 *Klonner*.

Pottia mutica Vent. c. fr.

Sh: near Kefar Saba, 1958 *Nemlik*; EV: Heftsi Ba, II.1944 K.

Pottia starkeana (Hedw.) C.M., c.fr.

J: Qiriyat Anavim, on earth-covered rock, with *Hymenostomum tortile*, V.1953 B.

Crossidium chloronotus (Bruch) Jur.

JD: Wadi Tse'elim, on stones, with *Funaria hygrometrica*, III.1957 B.

Crossidium squamigerum Jur.

UG: Wadi Hindaj, IV.1954 B.; JD: Wadi Massada, together with *Grimmia* sp., III, 1957 B.

Crossidium griseum Jur. c.fr.

JD: Massada summit, on dry place, together with *Aloina aloides*, III.1957 *B-jun.*

GRIMMIALES

Grimmia apocarpa Hedw.

P: near Gaza, s. d., *Hart* (n. v.).

Grimmia pulvinata Smith.

LJ: near Jericho, s. d., *Hart*.

Grimmia trichlophylla Grev.

LJ: near Jericho, s. d., *Hart*.

Grimmia campestris Bruch.

J: Qiriyat Anavim, from rock on woodland, V.1956 *B.*; LJ: near Jericho, s. d., *Hart*.

Grimmia crinita Brid.

JD: Wadi Massada, together with *Crossidium squamigerum*, III.1957 *B.* (probably).

FUNARIALES

Funaria convexa Schpr.

UG: throughout the whole wadi Tabahin-Limun-Amud several times, on earth and on stones, single or with *Funaria hygrometrica*, *Fissidens* sp. and *Targionia hypophylla*, V.1956 *B.*

Funaria dentata Crome.

She: Ben Shemen, woodland, on stones, I.1955 *B.*

Funaria mediterranea Lindb.

S: near Ein Hashofet, entrance to cave, on earth, III.1958 *B.*; JD: Wadi Tse'elim, on wet place, c. fr. III.1957 *B-jun.*

Funaria curviseta (Schwaegr.) Milde, c. fr.

UG: Wadi Amud, II, 1958 *Nemlik*; JD: Wadi Tse'elim, III.1957 *B.*

Funaria duriei (Mont.) Broth. var. **mustaphae** (Trab.) Bizot.

JD: Wadi Tse'elim, on wet sand, with *Gymnostomum calcareum*, III.1957 *B-jun.*; ibidem: Wadi Massada, on sand, near water place between rocks, with *Tortula atrovirens*, XII.1958 *B.*

EUBRYALES

Webera commutata Schpr.

Sh: Yarkon bridge, Herzliya, on earth X.1958 *B.*

Mniobryum latifolium Schiffn.

Sh: Yarkon bridge, Herzliya, on earth, VI.1952 *B.* (probably).

Bryum caespitium L.

Ca: Wadi Tira, s. d., *B.*; ibidem, near Yagur, s. d., *L*; Sh: Kefar Azar, on earth, XI.1955 *B.*; P: Zikkim, VI, 1955 *B.*; EV: Givat Hamore, II.1955 *B.*; She: Ben Shemen, I.1955 *B.*; J: Mt. Scopus, Jerusalem, Hebrew University gardens, VII.1955 *Klonner*; CN: Subeita, on stones and on earth, near old cistern, with variable border and arista, IV.1956 *B.*; ibidem: Mizpe Ramon, hole in the rock, IV.1959 *B.* (probably); JD: Wadi Tse'elim, III.1957 *B.*

Bryum capillare L.

Sh: Kadima, on earth, III.1955 *B.*; ibidem: Wadi Musrara-Ayalon, on old *Eucalyptus* log, X.1952 *B.*; EV: Givat Hamore, on rocks, II.1955 *B.*

Bryum torquescens Br. Eur.

Ca: Ahuza, dry water bed, with *Scorpiurium circinnatum* and *Trichostomum* sp. X.1956 B.;
Sh: Tel-Aviv, and Wadi Musrara, on wet earth and on old unused water pump, V.1955 B.

Bryum donianum Grev.

Ca: Ya'arot Hacarmel, with *Barbula vinealis* and *Fissidens impar*, XI.1955 B.; EV: Tel el Safi, X.1958, B.; J: Shaar Hagai and Nes Harim, IV.1955 B.

Bryum erythrocarpum Schwaegr.

She: Ben Shemen, dry woodland, I.1955 B.

Bryum bicolor Dicks.

Sh: Ramat Gan, XI.1952 B.; ibidem: Ramat Hasharon, IV.1955 B.; P: south of Tel-Aviv, I. 1956 B.; ibidem: Zikkim, IV, 1955 B.; EV: Kaukab al Hau'a, I.1957 B.; J: Beit Shemesh, II.1956 B.; NN: near Beersheba, s. d., Hart; CN: Makhtesh Hagadol, III.1956 B.; LJ: near Jericho, s. d., Hart.

Bryum murale Wils.

P: Tel Qassile, cistern wall, X.1958 B.; UG: Wadi Qarqara near Eilon, IV.1955 B.; ibidem: Wadi Limun, with *Tortula muralis*, V.1956 B.; EV: Mt. Gilboa, III.1925 Rab.; ibidem: Heftsi Ba, s. d., L.

Bryum argentum L.

Ca: Zikhron Yaacov, garden of House Daniel, with *Timmiella barbuloidea*, *Scorpiurium circinnatum* and *Rhynchostegiella tenella*, XI.1958 B.; Sh: near Kefar Saba, s. d., Nemlik; J: Mt. Scopus, Jerusalem, Hebrew University gardens, VII.1955 Klonner; LJ: Jericho: s. d., Hart.

Bryum splachnoides (Harv.) C.M.

CN: Wadi Muraphi-Ein Avdat, cascades, with *Didymodon tophaceus*, IV.1956 B.

Bryum canariense Schpr.

Ca: on rock, near Wizo school, sterile, with *Fossombronina* sp., IV, 1956 B.

ISOBRYALES

Zygodon viridissimus (Dicks.) R. Brown var. **vulgaris** Malta

J: Aqua Bella, on *Quercus calliprinos*, VI.1959, B.

Orthotrichum cupulatum Hoffm.

L: Fureides, to replace the formerly erroneously recorded *O. tenellum*.

HYPNOBRYALES

Pterogonium gracile Swartz.

UG: Mt. Haidar, on rocks, IV.1952 B.

Amblystegium riparium Br. Eur.

UG: Wadi Qarn, on rocks, half submerged, X.1956 B.

Hygroamblystegium irriguum (Hook. et Wils.) Lske.

Ca: Wadi Falah, in pouddle, V.1954 N.

Scorpiurium circinnatum (Brid.) Fl.

Ca: Ya'arot Hacarmel, IX.1955 B.; ibidem: Zikhron Yaacov, with *Bryum argentum* and *Rhynchostegiella tenella*, XI.1958 B.; UG: Mt. Haidar, IV.1952 B.; ibidem: Wadi Qarn, IV.1954 B.; ibidem: Wadi Limun, the type together with a very slender kind, V.1956 B.; EV: Mt. Tabor, entrance wall, together with *Camptothecium aureum*, X.1956 B.; J: Jerusalem, s. d., Reichert; ibidem: near Nes Harim, on stones, III.1959 B.; UJ: Tel el Qadi, IV.1954 B.

Camptothecium aureum (Lag.) Br. Eur.

UG: near Safed, on *Olea europaea*, IV.1954 B.; EV: Mt. Tabor, entrance wall, with *Scorpiurium circinnatum*, X.1956 B.; J: Nes Harim, on stones, III.1959 B.

Camptothecium sericeum (L.) Kindb.

J: Shaar Hagai, IV.1953 B.; ibidem: Solomon's pool, near Betlehem, s. d., Hart.

Camptothecium sericeum var. **robustum** Warnst.

J: near Nes Harim, on stones, IV.1957 B.

Rhynchostegiella tenella (Dicks.) Limpr.

Ca: Zikhron Yaacov, with *Timmiella barbuloidea*, *Bryum argentum* and *Scorpiurium circinnatum*, XI.1958 B.; UG: Wadi Limun, on dry rock, with *Tortella* sp. and *Scorpiurium circinnatum*, V.1956 B.; UJ: Tel el Qadi, on wet rocks and trees, IV.1954 B.

Eurhynchium meridionale (Schpr.) DeNot.

UG: Mt. Haidar, on rocks, with *Scorpiurium circinnatum*, IV.1952 B.

Eurhynchium swartzii Hobk.

UJ: Tel el Qadi, on *Quercus calliprinos*, IV.1954 B.

Eurhynchium confertum (Dicks.) Milde.

UG: Wadi Qarn, IV.1954 B.; J: Beit Govrin-Maresha, entrance to limestone cave, II.1956 B.

4 moss species, *Didymodon spadiceus* Limpr., *Crossidium griseum* Jur., *Bryum canariense* Schpr. and *Zygodon viridissimus* (Dicks.) R. Brown var. *vulgaris* Malta are new for our area, the last apparently also for the Eastern Mediterranean.

From all these collected records it can be said that the woody hill regions show a more or less variable moss flora, especially in the Upper Galilee with its abundant springs. In the coastal plains prevail Pottiales and some *Bryum*. The district of the Negev shows the typical flora of the arid and semi-arid zones. The list for the Eastern Negev with the Dead Sea area is more variable and richer, because of the many springs at Ein Gedi and its surrounding wadis.

LIST OF MOSSES FOUND IN SOUTHERN ISRAEL

CENTRAL NEGEV

<i>Fissidens minutulus</i>	<i>A. rigida</i> var. <i>pilifera</i>
<i>Gymnostomum calcareum</i>	<i>Tortula muralis</i>
<i>Gyroweisia tenuis</i>	<i>T. canescens</i>
<i>Timmiaella barbuloidea</i>	<i>T. cuneifolia</i> (probably)
<i>Didymodon tophaceus</i>	<i>Crossidium squamigerum</i>
<i>Hydrogonium ehrenbergii</i>	<i>Grimmia crinita</i>
<i>Barbula vinealis</i>	<i>Bryum caespitium</i>
<i>B. acuta</i>	<i>B. bicolor</i>
<i>Aloina rigida</i>	<i>B. splachnoides</i>

JUDAEN DESERT, EASTERN NEGEV AND SOUTH END OF DEAD SEA, EIN GEDI

<i>Gymnostomum calcareum</i>	<i>Tortula subulata</i>
<i>Eucladium verticillatum</i>	<i>T. atrovirens</i>
<i>Didymodon tophaceus</i>	<i>Crossidium squamigerum</i>
<i>D. luridus</i>	<i>C. chloronotos</i>
<i>D. spadiceus</i>	<i>C. griseum</i>
<i>Hydrogonium ehrenbergii</i>	<i>Pottia</i> sp.
<i>Barbula unguiculata</i>	<i>Grimmia crinita</i>
<i>B. rigidula</i>	<i>Funaria hygrometrica</i>
<i>B. fallax</i>	<i>F. mediterranea</i>
<i>Aloina ambigua</i>	<i>F. curviseta</i>
<i>A. aloides</i>	<i>F. durieui</i> var. <i>mustaphae</i>
<i>A. rigida</i> var. <i>pilifera</i>	<i>Bryum caespitium</i>
<i>Tortula muralis</i>	<i>B. splachnoides</i>

SOUTHERN NEGEV

<i>Gymnostomum calcareum</i>	<i>Didymodon tophaceus</i>
	<i>Bryum</i> sp. (probably <i>caespitium</i>)

ACKNOWLEDGEMENTS

I wish to express my sincerest gratitude for kind help and advice in identifying and checking many of the specimens, especially to Prof. Bizot, M. Potier de la Varde, Mr. A. C. Crundwell, Miss Appleyard and Miss Muirhead, and to Prof. Zohary for kind advice and loan of specimens from the Hebrew University.

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A NEW SPECIES OF *LEGUMINOXYLON* FROM THE MIO-PLIOCENE OF ISRAEL

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ABSTRACT

Leguminoxylon zoharyanum n.sp. is described from fractions of a silicified trunk, originally about 40 cm in diameter, from the Mio-Pliocene (Neogene) of Israel. The wood is diffuse-porous, with 6–9 vessels per mm. Growth rings are absent. The characters distinguishing *L. zoharyanum* from the most closely similar species, *Caesalpinioxylon ducis-aprutii* Chiarugi and *L. menchikofii* Boureau, are discussed. The absence of growth rings is not considered as providing conclusive evidence of a uniform climate.

Leguminoxylon zoharyanum n. sp. (Figures 1–4)

Description

A dicotyledonous wood without annual rings. The vessels are uniformly distributed, 6–9 per mm, solitary (32%) or in radial multiples of 2 (34%), 3 (22%) or 4 (12%) vessels. In addition there are some tangential multiples of 2–3 vessels. Small clusters of vessels are also present. In cross-section the vessels are somewhat elongated radially; generally they occupy almost the whole space between neighbouring rays. The maximum tangential diameter reaches 100 μ . Some vessels are occluded by resinous masses. Member length ranges between 120–280 μ . Vascular pitting is dense, with pits alternate, polygonal in outline, about 5 \times 4 μ . The perforation plate is transverse or slightly oblique, probably simple.

Parenchyma is abundant, paratracheal, vasicentric of the aliform confluent type mostly forming diagonal bands. Short tangential bands are also common. Rays are numerous, 8–12 per mm, bi- or tri-seriate, rarely uni-seriate (width 15–40 μ); height (6)12–18(35) cells, (200)300(400) μ . Rays wavy, diverging at the sides of vessels or almost straight. This character varies markedly even within a single slide.

The description is based on a well preserved fraction of a fossil trunk, originally 40 cm in diameter.

The wood was submitted for examination by Mrs. M. Pomeranzblum, of the Geological Survey of Israel, who kindly submitted for inclusion in this paper the following report: The wood was located on the surface of a sandstone outcrop which forms part of the Hatseva formation considered to be of Neogene age. Coordinates

1551/0426. A large number of small pieces of fossilized wood were found in the formation, mostly in a bad state of preservation. The specimen of *L. zoharyanum* was 5 m long and 20 cm in diameter. It is well preserved and does not show any sign of transportation. Mineralogical examination has shown silicification of the wood and the presence of limonite stains and minute quantities of CaCO_3 .

Discussion

The two species of fossil wood which most resemble *L. zoharyanum* are *Caesalpinioxylon ducis-aprutii* Chiarugi and *Leguminoxylon menchikofii* Boureau. *Caesalpinioxylon ducis-aprutii* was described from the Cretaceous of Italian Somaliland (Chiarugi 1933). *L. menchikofii* includes fossil wood from the Eocene found in Algeria, near Fort Flatters, $5^{\circ}20' \text{ W } 28^{\circ}30' \text{ N}$ (Boureau 1951). Table I summarizes the more important characteristics of the three species. It will be seen that *L. zoharyanum* resembles *C. ducis-aprutii* in the density of vessels as well as in the structure of the rays. It differs significantly in the parenchyma not being confined to very narrow sheaths surrounding the vessels. *L. menchikofii* shares with *L. zoharyanum* the more abundant parenchyma, but does not show oblique bands of parenchyma as highly developed as in the latter species. It is mainly distinguished from *L. zoharyanum* by the vessels, which are larger and much less frequent than in our species.

Leguminoxylon edwardsi Kräusel, from the Miocene or Oligocene, collected near Giza, Egypt, differs in having heterogeneous rays. *Leguminoxylon albizziae* Kräusel, possibly of the Lower Miocene of Wadi Faregh, Egypt, has 12–20 vessels per mm. Other species described by Kräusel also differ markedly from *L. zoharyanum*. *Evodioxylen oweni* (Carruthers) Chiarugi (= *Caesalpinioxylon oweni* (Carruthers) Edwards), included by Chiarugi (1933) in the Rutaceae, and collected from Lybia through Egypt to Somaliland, has only uni-seriate rays. Several species of fossil Dipterocarpaceae closely resemble *L. zoharyanum*, which is, however, devoid of the resin canals typical of that family.

The possible relation of woods of the genera *Leguminoxylon*, *Acacioxylen* and *Caesalpinioxylon* to present-day members of the Leguminosae is discussed by Kräusel (1939), Boureau (1951, 1953), Chiarugi (1933) and others. In this connection, it should be pointed out that today the only wild species of Leguminosae in the Near East which are at all likely to reach diameters of 40 cm belong to the genera *Acacia* (several species), *Cercis* (1 sp.) and *Ceratonia* (1 sp.). Of these, *Ceratonia* shows the closest resemblance with *Leguminoxylon zoharyanum*, while *Cercis* and the species of *Acacia* are rather different.

Kräusel (1924) mentions the absence or insignificance of annual rings in the fossil woods from Egypt as indicating the absence of any pronounced annual cycle of temperature and humidity. Warm and humid conditions are supposed to have prevailed there from the Cretaceous to the Oligocene-Miocene. In the light of more recent work, trees without growth rings do grow in places, such as Israel, with pro-

TABLE 1

Summary of main characters of *L. zoharyanum*, *Caesalpinioxylon ducis-aprutii*, *L. menchikofii*

		<i>Caesalpinioxylon ducis-aprutii</i>	<i>Leguminoxylon menchikofii</i>	<i>Leguminoxylon zoharyanum</i>
Annual rings		"Not distinguishable"	"Practically absent"	None
Vessels	Number per mm ²	(4)6-8(9)	2-3	6-9
	Arrangement in radial groups	Mostly single, sometimes 2 or 3	Single 66%, in pairs 30%, triplets 4%	Single 32%, pairs 34%, triplets 22%, fours 12%
	Tangential diameter	(60)110(-200) μ	(100)200(300) μ	Maximum 110 μ
	Orientation of perforation plate	Oblique	Horizontal or slightly oblique	Horizontal or slightly oblique
Parenchyma		Paratracheal, not more than 1-2, rarely 3 cells wide, some cells dispersed among fibres	Paratracheal aliform often tangential or obliquely confluent, very rarely more than 2-3 vessels in tangential sense	Abundant, vasicentric of the aliform confluent type mostly forming diagonal bands
Rays	Type of ray	Homogeneous, bi-seriate, at most tri-seriate; uni-seriate very rare	Homogeneous, mostly bi-seriate, sometimes tri-seriate, rarely uni-seriate	Homogeneous, bi-tri-seriate, rarely uni-seriate.
	Height	10-20 cells (200-400 μ)	(6)12-18(35) cells, about 300 μ	(200)300(400) μ
	Width	30-50 μ	35-85 μ	(30)40(50) μ
	Number per mm	about 8	About 10	8-12
Age		Cretaceous	Eocene (Danian)	Mio-Pliocene (Neogene)

nounced annual cycles of temperature and rainfall (Fahn 1959). Thus today this type of wood structure is not infrequent in a climate in which generally rings do occur (Fahn 1955). Thus the absence of growth rings in *L. zoharyanum* may have to be interpreted by historical circumstances and cannot be accepted as conclusive evidence of a uniform climate.

Diagnosis

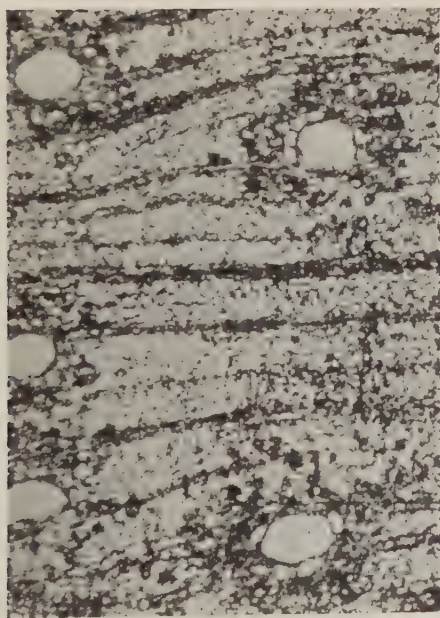
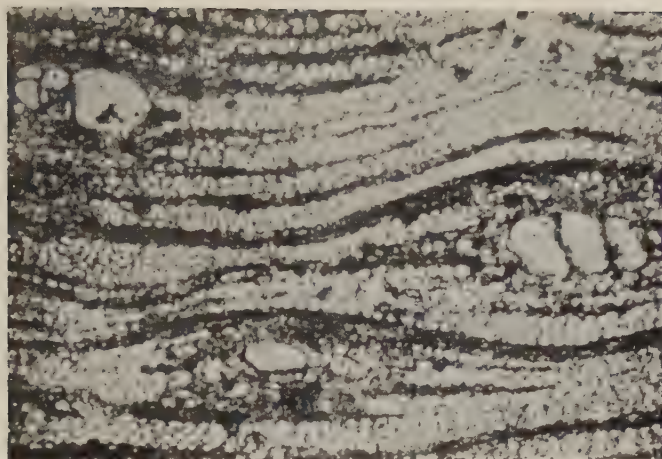
Dicotyledonous wood without annual rings. Vessels solitary or in radial groups of 2-3, rarely 4, averaging 6-9 vessels per mm². Parenchyma abundant, vasicentric, of the aliform confluent type, mostly forming diagonal bands. Rays bi- or tri-seriate, homogeneous.

Mio-Pliocene, Southern Israel.

The type slides (L 250, L 251), together with a part of the wood, are deposited at the Department of Botany, The Hebrew University of Jerusalem. Samples have been sent to the Geological Department of the British Museum, and to the Museum National d'Histoire Naturelle, Paris.

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Figures 1-2

Leguminoxylon zoharyanum n. sp. Two views of L 250, showing variation in the waviness of the rays.
× 75.

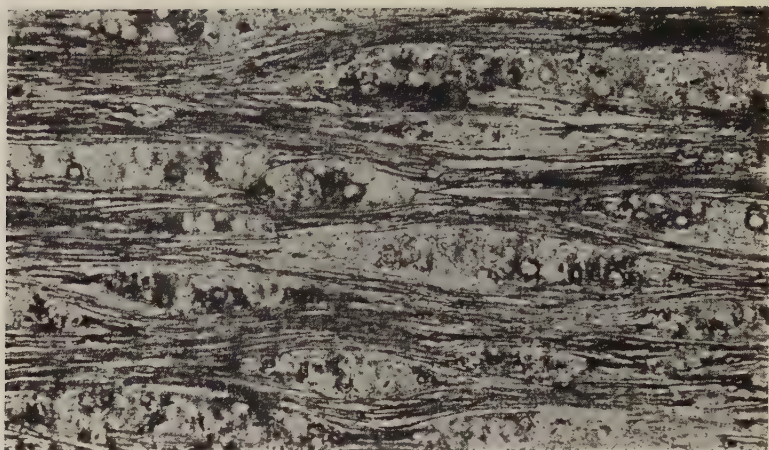


Figure 3
L. zoharyanum n. sp. L 251, tangential section. $\times 160$

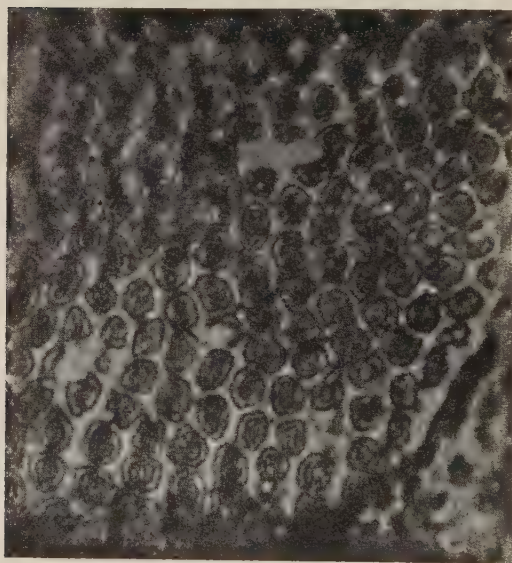


Figure 4
L 251, part of two vessel members, showing alternate pitting and oblique wall. $\times 950$.

OBSERVATIONS ON THE PHENOLOGY OF SPRING WHEAT, BARLEY AND OATS

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ABSTRACT

Observations were carried out on jointing and heading of spring wheat, barley and oats, sown on seven successive dates from the end of November to the middle of June.

The number of days from emergence to jointing and from jointing to heading were correlated with temperature and daylength prevailing at these periods.

The genotypic differences between early and late varieties regarding jointing and heading dates were estimated by the differences between the multiple regression equations of these varieties.

INTRODUCTION

Under given agricultural conditions, temperature and daylength appear to be the most important environmental factors determining the time of heading of any cereal variety.

Heading is preceded by differentiation of head initials which occurs at the jointing stage. It may be assumed that the differentiation of head initials and the subsequent development, up to the eventual emergence of heads out of the flag leaf, are determined separately by genotypic as well as environmental factors.

In this study an attempt has been made to analyze the effects of temperature and daylength on early and late varieties of wheat, barley and oats separately for the periods from emergence to jointing and from jointing to heading.

The observations were carried out on plants grown in the field under uncontrolled conditions of temperature and daylength which in most cases did not permit to distinguish between the effects of temperature, daylength and their interaction. An attempt has therefore been made to analyze the data by testing multiple and partial correlation and regression coefficients.

REVIEW OF LITERATURE

Wheat, barley and oats are generally considered long day plants (Klages 1942). It is further postulated that an increase in temperature promotes the heading of these cereals. However, Riddel and Gries (1958) have established a delaying effect of high temperatures (21° – 27° C) on the appearance of floral initials of spring wheats.

Nuttonson (1948) has shown that a multiple of the average length of day and the summation of total day degrees provided the least variable mathematical expression for the interval between the dates of emergence and first heading of Marquis wheat sown at succeeding dates from the end of October up to the beginning of July in Maro, Oregon.

Borthwick et al. (1941) investigated the effect of photoperiod and temperature on the development of barley and found that the mean number of days required from sowing to heading was mainly affected by the photoperiod prevailing up to the age of 4 weeks. A daylength of 12 hours brought about a delay in heading as compared with 16, 20, and 24 hour photoperiods which did not differ in their effect on the time of heading. They also found that low temperature during the seedling stage retarded the differentiation and development of the spikelet primordia.

Wiggans (1956) and Wiggans and Frey (1957) studied the effect of photoperiod and temperature on oats. In their experiments no heads were produced under 9 or 12 hour photoperiods. When, however, the 9 hour photoperiod was supplemented with one hour at midnight, head producing tillers were formed. With photoperiods of 15 hours or longer, all the varieties investigated produced heads. The accumulation of temperature over 5.5°C , required to mature a given variety of oats, was found by them to be nearly constant for a series of sowing dates and for several years.

Siev's studies (1949) of the phenology of certain wheat varieties in Israel have established that the early varieties B.I.P.M. and C.C.C. attained the heading stage in days shorter than 12 hours. Furthermore, Gries et al. (1956), concluded as a result of their investigations on spring wheat, that "all varieties flowered over the entire range of daylength used but became progressively earlier as the photoperiod was increased from 8 to 24 hours."

On the other hand, Stroun (1956) working with early durum varieties such as Zenati \times Bouteille found that daylength shorter than 8 hours retarded differentiation of spike initials but ceased to have any influence after the plants had reached a certain stage in the differentiation of the spike.

EXPERIMENTAL PROCEDURE

From November 1955 until June 1956 monthly sowings of an early and a late variety of wheat (B.I.P.M. and Merit), barley (Nissani and 0-77) and oats (Buddah and Canada Standard Feed Oats No. 2, referred to hereafter as "Canadian")* were carried out in 10 sq m plots on the trial grounds of the Faculty of Agriculture at

* B.I.P.M. is an Australian wheat variety grown to a small extent in the Jordan valley. Merit is an American variety grown experimentally.

Nissani is a local selection from Egyptian Mariout barley grown extensively.

0-77 is a North African barley variety introduced to Israel from Tunisia and was extensively grown.

Buddah is an Australian oat variety grown experimentally.

"Canadian" oats are also grown only experimentally.

Rehovot. The varieties chosen are, respectively, the earliest and latest varieties available at present from collections grown in Israel.

Dates of jointing and of heading were recorded when 50% of the plants had reached the respective stages.

Daylength, as referred to in this study, denotes the time from sunrise to sunset at the Lydda Meteorological Station.

Temperature was recorded by means of a thermograph at the meteorological station of the Agricultural Research Station located at a distance of about 300 metres from the plots (Table I).

TABLE I
Temperatures (°C) during the period of the experiment

Month	Mean			Extreme	
	Daily	Minimum	Maximum	Minimum	Maximum
1955					
November	17.6	14.3	23.0	11.0	27.5
December	13.4	10.0	19.4	7.0	25.3
1956					
January	11.8	8.2	18.5	5.5	24.8
February	13.3	9.3	20.0	5.2	28.5
March	12.7	8.7	19.5	3.5	26.2
April	16.7	11.1	24.9	4.2	35.8
May	19.0	13.6	29.0	10.0	31.0
June	23.0	17.9	30.2	15.0	36.0
July	24.9	19.9	32.2	16.5	36.0
August	26.4	20.2	32.3	18.0	37.0

The multiple and partial regression and correlation coefficients have been computed according to Goulden (1952).

RESULTS AND DISCUSSION

Effect of date of sowing

The period from emergence to heading decreased in all varieties from the first to the sixth sowing (Table II). At the seventh sowing, however, this period for the late variety in each of the three cereals was markedly longer than it had been at the sixth sowing. The difference in number of days from emergence to heading, between the early and late varieties was largest for wheat. The early oat variety Buddah, at the fifth, sixth and seventh sowings, adopted a prostrate habit of growth when the seedlings were about one month old and, with the exception of a few plants at the fifth sowing, did not reach the heading stage at all. The Buddah variety did, however, reach the jointing stage at the fifth and sixth sowing, although much later than the Canadian variety (Table III).

Separate data on the periods from emergence to jointing and from jointing to heading are presented in Tables III and IV.

TABLE II
Period from emergence to heading

	Sowing	Date of emergence	Day-length at emergence	Date of heading		Mean daylength (hours)		Mean daily temperature (°C)		Number of days	
				Early var.	Late var.	Early var.	Late var.	Early var.	Late var.	Early var.	Late var.
Wheat	1	29.11	10 ^h 15'	18.2	21.4	10.4	11.4	12.5	13.2	81	144
	2	31.12	10 ^h 06'	10.3	25.4	10.9	11.5	12.4	13.3	70	116
	3	6.2	10 ^h 48'	2.4	8.5	11.7	12.3	12.9	14.4	56	92
	4	13.3	11 ^h 53'	24.4	20.5	12.6	13.0	14.5	15.9	42	68
	5	19.4	13 ^h 05'	22.5	10.6	13.5	13.7	17.8	19.2	33	52
	6	14.5	13 ^h 46'	12.6	1.7	14.1	14.1	20.9	22.0	29	48
	7	12.6	14 ^h 13'	12.7	7.8	14.2	14.0	23.7	25.1	30	56
Barley	1	29.11	10 ^h 15'	25.2	25.3	10.5	10.9	12.7	12.8	88	117
	2	31.12	10 ^h 06'	22.3	10.4	11.1	11.4	12.6	12.9	82	101
	3	6.2	10 ^h 48'	8.4	—*	11.8	—*	13.4	—*	62	—*
	4	13.3	11 ^h 53'	30.4	—*	12.7	—*	15.1	—*	48	—*
	5	19.4	13 ^h 05'	23.5	4.6	13.5	13.7	17.9	18.9	34	46
	6	14.5	13 ^h 46'	12.6	20.6	14.0	14.1	20.9	21.7	29	37
	7	12.6	14 ^h 13'	12.7	23.7	14.2	14.1	23.7	24.0	30	41
Oats	1	30.11	10 ^h 14'	20.3	20.4	10.9	11.3	12.8	13.2	111	142
	2	1.1	10 ^h 06'	30.3	26.4	11.2	11.6	12.6	13.4	89	116
	3	7.2	10 ^h 49'	8.4	12.5	11.8	12.2	13.4	14.6	61	95
	4	13.3	11 ^h 53'	26.4	20.5	12.6	13.0	14.8	15.9	44	68
	5	19.4	13 ^h 05'	—	8.6	—	13.7	—	19.1	—	50
	6	14.5	13 ^h 46'	—	27.6	—	14.1	—	21.9	—	44
	7	13.6	14 ^h 14'	—	31.7	—	14.1	—	24.5	—	48

* Plants suffered severely from *Erysiphe graminis* and were therefore discarded.

The figures presented in Table V indicate that for all varieties except B.I.P.M. wheat, the greater portion of the variation in number of days from emergence to heading was due to the period from emergence to jointing. This relationship received an extreme and highly significant expression in the case of Merit wheat and Buddah oats.

A comparison of the mean squares of the early and the late varieties indicates that the effect of sowing date on the jointing time of Merit wheat was significantly higher than on the jointing time of B.I.P.M.. There was, however, no significant difference in the effect of sowing date on the period from jointing to heading of these two varieties. In barley the effect of sowing date was stronger, though not significantly, on the late variety than on the early one for both jointing and heading. For the four comparable sowings of oats the effect of sowing date on the period from jointing to heading was significantly higher for the Canadian variety than for Buddah, whereas

TABLE III
Period from emergence to jointing

Sow- ing		Date of jointing		Daylength at jointing		Mean daylength (hours)		Mean daily temperature (°C)		Number of days	
		Early var.	Late var.	Early var.	Late var.	Early var.	Late var.	Early var.	Late var.	Early var.	Late var.
Wheat	1	2.1	15.3	10 ^h 06'	11 ^h 57'	10.1	11.0	13.4	12.8	34	107
	2	5.2	17.3	10 ^h 46'	12 ^h 01'	10.6	11.0	11.8	12.6	36	77
	3	10.3	30.3	11 ^h 47'	12 ^h 27'	11.4	11.7	13.0	13.0	33	53
	4	7.4	23.4	12 ^h 43'	13 ^h 12'	12.4	12.6	13.6	14.4	25	41
	5	8.5	20.5	13 ^h 37'	13 ^h 54'	13.3	13.5	17.4	17.9	19	31
	6	2.6	10.6	14 ^h 08'	14 ^h 12'	14.0	14.0	20.2	20.8	19	27
	7	2.7	20.7	14 ^h 12'	13 ^h 56'	14.2	14.1	23.5	23.9	20	38
Barley	1	22.1	10.2	10 ^h 26'	10 ^h 55'	10.2	10.4	12.7	12.6	54	73
	2	20.2	10.3	11 ^h 12'	11 ^h 47'	10.7	11.0	12.0	12.4	51	70
	3	12.3	1.4	11 ^h 51'	12 ^h 31'	11.4	11.7	13.1	12.9	35	55
	4	5.4	—*	12 ^h 38'	—*	12.3	—*	13.0	—*	23	—*
	5	8.5	17.5	13 ^h 37'	13 ^h 50'	13.3	13.5	17.5	17.8	19	28
	6	30.5	7.6	14 ^h 05'	14 ^h 10'	14.0	14.0	19.9	20.8	16	24
	7	1.7	10.7	14 ^h 13'	14 ^h 07'	14.2	14.2	23.7	23.7	19	28
Oats	1	18.2	18.2	11 ^h 09'	11 ^h 09'	10.6	10.6	12.5	12.5	80	80
	2	4.3	13.3	11 ^h 36'	11 ^h 53'	10.8	11.0	12.3	12.5	63	72
	3	15.3	5.4	11 ^h 57'	12 ^h 38'	11.5	11.7	13.2	13.1	37	58
	4	5.4	15.4	12 ^h 38'	12 ^h 57'	12.3	12.5	13.0	14.0	23	33
	5	1.7	15.5	14 ^h 13'	13 ^h 47'	13.9	13.4	20.5	17.6	73	26
	6	20.7	6.6	13 ^h 56'	14 ^h 10'	14.0	14.0	22.6	20.8	67	23
	7	—	31.7	—	14 ^h 05'	—	14.2	—	22.9	—	29

* Plants suffered severely from *Erysiphe graminis* and were therefore discarded.

the effect of sowing date on the period from emergence to jointing of the two varieties did not differ significantly.

It is also obvious from the data in Tables III and IV that the increase in number of days from emergence to heading at the last sowing was entirely due to an elongation of the period from emergence to jointing.

Effects of temperature and daylength

The effects of temperature and daylength which showed a high degree of correlation (r_{tl} , Table VI) could not be entirely separated in view of the uncontrolled conditions of the experiment. Consequently the multiple correlation between the number of days and the combined effect of temperature and daylength ($R_{n,tl}$) was computed. The values of R^2 (Table VI) indicate that for all varieties tested (except Buddah oats which were excluded from this analysis) a significant, and in most cases, highly significant portion of 88–99% of the variations in the number of days from emergence

TABLE IV
Period from jointing to heading

Sow- ing		Mean daylength (hours)		Mean daily temperature (°C)		Number of days	
		Early var.	Late var.	Early var.	Late var.	Early var.	Late var.
Wheat	1	10.6	12.5	11.8	14.3	47	37
	2	11.3	12.6	13.1	14.6	34	39
	3	12.2	13.0	12.7	16.4	23	39
	4	13.0	13.6	15.8	18.1	17	27
	5	13.8	14.1	18.3	21.2	14	21
	6	14.2	14.2	22.3	23.6	10	21
	7	14.2	13.7	24.1	27.6	10	18
Barley	1	11.0	11.6	12.6	13.3	34	44
	2	11.8	12.2	13.5	14.1	31	31
	3	12.4	—*	13.9	—*	27	—*
	4	13.1	—*	16.9	—*	25	—*
	5	13.8	14.0	18.4	20.6	15	18
	6	14.1	14.2	22.2	23.3	13	13
	7	14.2	14.0	23.8	24.8	11	13
Oats	1	11.6	12.1	13.8	14.1	31	62
	2	12.0	12.5	13.2	14.8	26	44
	3	12.3	13.1	13.7	17.0	24	37
	4	13.0	13.4	16.6	17.7	21	35
	5	—	14.0	—	20.8	—	24
	6	—	14.2	—	23.2	—	21
	7	—	13.9	—	27.0	—	19

* Plants suffered severely from *Erysiphe graminis* and were therefore discarded.

to jointing and from jointing to heading were due to linear regression on the mean daily temperatures and mean daylength prevailing at these periods.

The correlation between number of days from emergence to jointing and mean daily temperature in cases where the mean daylength was not changing (partial correlation) was significant only for Nissani barley and Canadian oats. The positive value of its coefficients ($r_{nt.t}$) indicates that an increase in temperature caused a delay in jointing.

The partial correlation between number of days from emergence to jointing and mean daylength was significant or highly significant and its coefficients ($r_{nt.t}$) were of negative value and of high magnitude for all the varieties tested. This points to the fact that in all cases where the mean temperature was not changing, which applies fairly well to the first three or four sowings, the increase in daylength significantly promoted jointing. The mean daily temperature being constant, a portion of

73-97% of the variation in number of days from emergence to jointing could be attributed to linear regression on mean daylength.

TABLE V

Mean squares of the number of days from emergence to jointing and from jointing to heading

Variety		Emergence to jointing		Jointing to heading		<i>F</i> value ²	Probability of higher <i>F</i> value ³
		M.S. value	M.S. % ¹	M.S. value	M.S. % ¹		
Wheat	B.I.P.M.	57.62	13.8	191.1	44.5	3.32	8.5%
	Merit	836.6	62.5	86.15	6.4	9.71	0.7%
Barley	Nissani	253.7	41.8	84.90	14.0	3.06	10.0%
	0-77 ⁴	606.8	42.8	181.7	12.8	3.34	13.5%
Oats	Buddah ⁵	654.9	74.3	17.67	2.0	37.07	0.9%
	Canadian	560.5	38.5	230.9	15.9	2.43	15.2%

¹ Mean square expressed as percentage of the mean square for the number of days from emergence to heading.

² Ratio of the two mean squares (greater M.S. : smaller M.S.)

³ Computed according to R. A. Fisher and F. Yates, *Statistical Tables*, Fifth edition (1957), page 3.

⁴ For five comparable sowings.

⁵ For four comparable sowings.

TABLE VI

Correlation coefficients

Variety	Emergence to jointing				Jointing to heading			
	$R^2_{n.tl}$	$r_{n.tl}$	$r_{n.lt}$	r_{tl}	$R^2_{n.tl}$	$r_{n.tl}$	$r_{n.tl}$	r_{tl}
B.I.P.M.	0.9158**	0.1157	-0.8511*	0.8877**	0.9706**	0.6462	-0.3011	0.9107**
Merit	0.8813*	0.2278	-0.8858*	0.9269**	0.9281**	-0.7723	-0.7284	0.7987*
Nissani	0.9740**	0.8670*	-0.9718**	0.8999**	0.9662**	-0.6174	-0.7785	0.9286**
0-77	0.9841**	0.6343	-0.9601**	0.9405**	0.9561*	-0.2569	-0.7590	0.9525**
Canadian	0.9904**	0.9486**	-0.9873**	0.9361**	0.9412**	-0.4099	-0.8493*	0.8646*

n — number of days; *t* — mean temperature; *l* — mean daylength; *R* — multiple correlation coefficient

* exceeding the 5% point of significance

** exceeding the 1% point of significance

The values of the partial correlation coefficients for the period from jointing to heading were below the 5% point of significance (with the one exception of $r_{nl,t}$ for Canadian oats) indicating that there was no sufficient supply of data to separate the effects of temperature and daylength for this period.

The magnitude of the relative weight of the effect of daylength measured in hours — c (Table VII) was on the average about ten times greater than the relative weight of the effect of temperature measured in centigrades — b .

TABLE VII
*Partial regression coefficients**

	Variety	Emergence to jointing		Jointing to heading	
		b	c	b	c
Wheat	B.I.P.M.	0.127	-4.741	0.999	-12.453
	Merit	6.144	-37.513	-1.013	-6.360
Barley	Nissani	2.294	-15.250	-0.813	-4.595
	0-77	1.412	-17.424	-0.468	-8.947
Oats	Canadian	4.613	-28.453	-0.703	-14.851

* The regression equation in this case is:

$$N - \bar{n} = b(t - \bar{t}) + c(l - \bar{l})$$

or $N = a + bt + cl$

where N = number of days according to regression equation

\bar{n} = mean n

\bar{t} = mean t

\bar{l} = mean l

b and c = partial regression coefficients

$$a = \text{constant portion} = \bar{n} - b\bar{t} - c\bar{l}$$

Threshold effects

The mean daylengths for the period from emergence to jointing of the Merit wheat variety at the first and second sowings were identical and the mean temperatures were almost so, and yet the length of this period at the second sowing was thirty days less than at the first sowing. This phenomenon might be attributed to a threshold effect of daylength inhibiting jointing as long as daylength had not reached a certain minimum. No such effect could be detected in B.I.P.M. wheat, the jointing of which took place even at $10^h06'$ daylength, the shortest day being $10^h03'$.

Earliness and lateness

The expected differences in jointing and heading time between the early and the late varieties, under equal environmental conditions (within the limits of those tested), will be due to differences in genotypic effects and to differences in interaction effects of the genotypes of the varieties with temperature and daylength. Considering the high and highly significant values of R^2 (Table VI), these differences may be estimated by the differences between the regression equations for the late (subscript L) and for the early (subscript E) varieties*:

$$N_L = a_L + b_L t + c_L l$$

$$N_E = a_E + b_E t + c_E l$$

$(a_L - a_E)$, $(b_L - b_E)$ and $(c_L - c_E)l$ will be estimates of the difference in genotypic effects of the two varieties, the difference in interaction effects of the genotypes of the two varieties with temperature " t " and the difference in interaction effects of the genotypes of the two varieties with daylength " l " respectively.

Substituting the obtained values of a , b and c yields the figures listed in Table VIII.

TABLE VIII
Estimates of differences in genotypic and interaction effects

	Emergence to jointing			Jointing to heading		
	$a_L - a_E$	$(b_L - b_E)t$	$(c_L - c_E)l$	$a_L - a_E$	$(b_L - b_E)t$	$(c_L - c_E)l$
Wheat	340	6.017 t	-32.772 l	-30	-2.012 t	6.093 l
Barley	58	-0.882 t	-2.174 l	55	0.345 t	-4.352 l

The difference in genotypic effects between the two wheat varieties as well as the differences in interaction effects were markedly higher for the period from emergence to jointing than for the period from jointing to heading. For barley, however, the difference in genotypic effects between the two varieties was almost identical for the two periods under consideration.

The genotypic difference between the two wheat varieties, regarding the number of days from emergence to jointing, was almost six times greater than this genotypic difference between the two barley varieties. Phenotypically (Table III) the highest observed difference between the two wheat varieties was 73 days at the first sowing compared with a difference of 19 days between the two barley varieties at the same sowing.

The figures in Table VIII also indicate that under certain conditions of temperature and daylength the phenotypic differences in jointing or heading time may be nullified or even reversed.

* For derivation and explanation of symbols see footnote in Table VIII.

SUMMARY AND CONCLUSIONS

1. Spring wheat, barley and oats, an early and a late variety of each, were sown on seven successive dates from the end of November to the middle of June.

2. Data on jointing and heading dates have been presented together with the mean daylengths and mean daily temperatures prevailing during the periods of emergence to jointing and jointing to heading.

3. For all varieties except B.I.P.M. wheat the greater portion of the variation in number of days from emergence to heading was due to variation in number of days from emergence to jointing.

4. It has been shown by means of the multiple correlation coefficients that a significant portion of 88–99% of the variations in the number of days from emergence to jointing and from jointing to heading were due to linear regression on the mean daily temperatures and mean daylengths prevailing at these periods.

5. The partial correlation coefficients have indicated that when the mean temperature was not changing an increase in daylength significantly promoted jointing.

6. A threshold effect of daylength on the jointing of Merit wheat has been detected.

7. The differences in genotypic effects, regarding jointing and heading dates, between the early and the late varieties and the differences in interaction effects of the genotypes of these varieties with temperature and daylength have been estimated by the differences between the multiple regression equations for the late and for the early varieties.

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CEPHALIOPHORA TROPICA THAXTER, A RARE HYPHOMYCETE ISOLATED FROM SEEDS IN ISRAEL

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ABSTRACT

A new record of the rare tropical fungus *Cephalophora tropica* is reported in this paper. The fungus occurs on the seeds of *Trigonella arabica*, a new host to this fungus. The optimal growth of the colony on Czapek's was at 26–30°C. Production of conidia was abundant on all media used. Enzymatic activity results in the liquefaction of gelatine, utilization of starch; failure to decompose cellulose and to liquify pectin.

INTRODUCTION

The genus *Cephalophora* was created by Thaxter (1903) and two species were recognized: *C. tropica* and *C. irregularis*. Both were isolated from dung of various animals in Jamaica, Liberia, Java, China and Puerto Rico. Clements and Shear (1931) classified this genus as "fimicole".

More recent publications, however, prove that the genus is not confined to dung only. *C. tropica* has been isolated in North Carolina from decaying tobacco leaves (Wolf 1949), from the rhizosphere soil of *Cajanus cajan* (L.) Millsp., from soil in India (Agnihotrudu and Barua 1957), in Australia (Crook and Hindson 1955, cf. Agnihotrudu and Barua 1957), and in Barbados (Routien 1958). *C. irregularis* has been isolated from decaying moist wood (Subramanian 1953) and from the rhizosphere of tea plants (Agnihotrudu and Barua 1957).

In the summer of 1957, while examining seed-borne fungi, *Cephalophora tropica* was isolated by us from seeds of *Trigonella arabica* Del., collected in November 1954 in the vicinity of Beersheva, Negev. *Trigonella arabica* is a steppico-desertic plant, belonging to the Saharo-Sindian element of our Flora and known only in Palestine, Sinai and Egypt (Eig 1932).

The morphological features of *Cephalophora tropica* correspond to the descriptions of Thaxter (1903), Wolf (1949), Agnihotrudu and Barua (1957) and Routien (1958).

EXPERIMENTAL

The seeds of *Trigonella arabica* were germinated in Petri dishes on moistened blotting paper, at room temperature. *Cephalophora* covered the whole seed-coat with pale-buff capitate hyphae bearing densely crowded phragmosporous conidia (Figure 1).

It also spread to the wet blotting paper forming cinnamon-coloured colonies. The fungus seems to be of saprophytic nature since it does not inhibit the germination of the seeds.

The seedlings develop normally, their hypocotyls elongate carrying upwards the seed coat covered by *C. tropica*.

The conidiophore arises, as a rule, as a lateral proliferation from a cell of a vegetative hypha 5–6 μ in diameter, elongates and swells towards the apex forming a vesicle which is separated from the rest by a cross-wall (Figure 2). Sometimes it grows also intercalary as a sessile spherical head bearing conidia (Figure 3). The conidiophores are variable in length, continuous or 1–3 septate, smooth, the vesicles being 27–35 μ long and 13–22 μ broad. The conidia are initiated as bud-like protrusions (Figures 2, 3) and are pyriform to cylindroclavate in shape (Figure 1).

The mature conidia are 27–46 μ , occasionally up to 60 μ long and 14–16 μ broad. 3–5 and seldom 6–7 septate, cinnamon-brown, smooth, heavily-walled and thickened at the septa to 2–3 μ . The walls of the apical rounded cell and the basal triangular one are thinner and therefore paler in colour than the rest of the cells.

Growth of *Cephalophora tropica* was found satisfactory and production of conidia abundant on all the following media: Potato dextrose agar, Czapek's modified agar, Czapek's malt agar, Gelatine, Starch agar and Salts agar + cellulose.

Cephalophora tropica liquified gelatine, utilized all the available starch, failed to decompose cellulose and did not liquify pectin.

Cephalophora tropica was cultivated on Czapek's in Petri dishes during 12 days in light at a range of temperatures between 15°–40°C, and optimal growth was found to occur between 26°–30°C (see Table I).

TABLE I
Effect of temperature on growth of *Cephalophora tropica*

Temp. (°C)	15	20	26	30	37	40
Diam. of colony (mm)	25	35	75	85	30	10

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Figure 1
Mature conidia forming the typical "rosette".

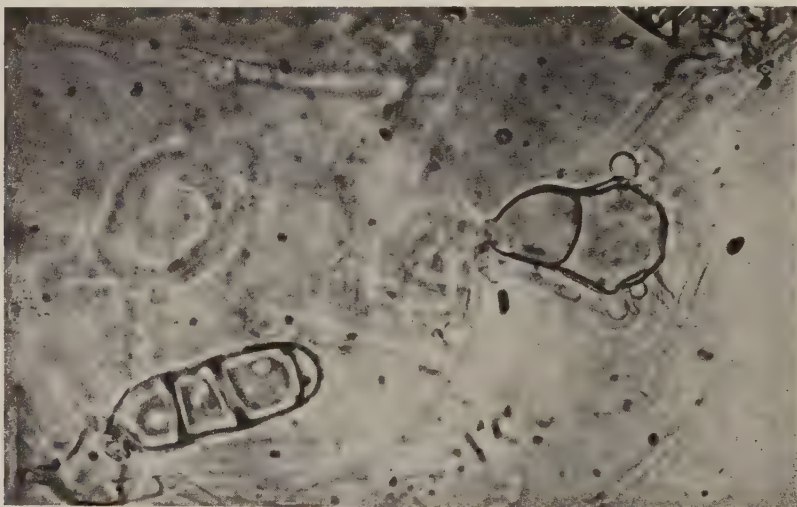


Figure 2
Septation of the conidiophore and budding of the conidia.



Figure 3
Formation of conidia on the intercalary formed vesicle.

A PRELIMINARY REPORT ON THE POLLEN FLORA OF LAKE HULA, ISRAEL*

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ABSTRACT

A study of samples taken at irregular intervals down to a depth of 120 m from a boring in Lake Hula, in Northern Israel, has shown well-preserved pollen grains at all levels, in both peat and mineral deposits. The frequency of the pollen grains was generally low to very low. Tree pollen occurred in widely varying amounts but could not serve as a basis for computations of frequencies. Nor should it be used, owing to the conditions which presumably prevailed in the area throughout the Pleistocene. The counts—referring to the levels—show Gramineae, among the families, and *Quercus*, among the genera, to be most highly represented, with the former up to 50% and the latter up to 40% of the total counts at some levels. The occurrence of *Olea* at some levels is of special interest, due among other things to the semi-anemophily of *Olea*. The low frequency of Cyperaceae is presumably due to the corrodability of the grains of this family. This may also be the case with *Salix* and *Tamarix*. In view of the large vertical distance between samples, no pollen diagram is included.

INTRODUCTION

Lake Hula is part of the Jordan Valley Rift which originated at the first down-faulting at the turn of the Pliocene to the Pleistocene (Picard 1952, for further details). According to Picard (1952) the bulk of the 120 m Hula Series should be ascribed to the Lower Pleistocene. With the outlet of the lake at a fixed height, the continuous production of peat throughout a long period of time requires a slow but steady subsidence of the deposits. During recent times the rate of subsidence must have been similar to the rate of peat formation, as the cutting in 1958 of a channel only a few metres deep has drained the lake as well as the adjacent swamp and has put an end to the formation of peat.

Today the catchment area of Lake Hula above its southern tip comprises 1,530 km² with an average rainfall of 900 mm. The Hula area extends over 187 km², of which 80 km² are occupied by the former lake and swamp, with about 500 mm rainfall. Transport of pollen grains by surface runoff from the whole of the catchment area was undoubtedly not inconsiderable.

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The surface peat, a few metres thick, is underlain by a 25 to 50 m "barren" zone of limnic chalk and clay followed by the main fossil peat horizon. In some borings this horizon is rather uniform down to 80 or more metres, whereas in others it is strongly intercalated with limnic chalks and clays. Deeper peat horizons were found at a depth of 120 m. No facial differences were observed within either peat or sterile beds with increase in depth, and the basal strata of the surface peat are similar in aspect to the fossil peat (Picard 1952).

MATERIAL AND METHODS

The samples studied were taken from a boring in the area of the swamp at 35°36'0"E, 33°05'20"N, 20640/27914 of the Israel grid. Samples were removed at irregular intervals to the total depth of 120 m. Material for the present study was removed from the interior of the available core sections to preclude contamination. It was treated by Erdtman's acetolysis method after removal of limestone and silica. Particular care was taken to repeat the washings with hydrochloric acid until a clear solution was obtained. In a few instances ten or more washings were required. Material for comparison obtained from recent plants was prepared by Erdtman's method, with bleached and unbleached grains in each slide. The collection of recent grains is far from complete, yet all members of the arboreal flora, listed by Zohary (1951), as well as aquatic plants and other leading plants of the region, are included.

A review of the plant communities of the Hula Plain—prior to the draining of the swamps and the lake—has been published by Zohary and Orshansky (1947).

RESULTS

Table I is a summary of the counts made. No slide contained more than about 300 grains under a large (52 × 24 mm) cover-glass. At most levels more than 150 grains were counted. At others, owing to the extreme paucity of grains, the number counted was smaller, down to as few as 70. The table shows frequencies rounded off to the nearest per cent. It is evident that Gramineae among the families, and *Quercus* among the genera are most heavily represented. At two levels the porate grains of the Centrospermae become the dominant group while among individual genera, *Olea* (at 18.5 m), *Sparganium*, *Nymphaea* and cf. *Artemisia* approach values of 10 per cent. Coniferae were poorly represented at all but two levels, sometimes by fractured grains.

Diatoms were abundant at several levels, and a separate study of variations in their population may well provide an interesting sidelight to the results of pollen analysis. The methods used in this study involved the destruction of all diatoms. Other microfossils included teleutospores of *Puccinia* (2–3 m), and what resembled conidia of *Papulaspora* (18.5 m) and *Pediastrum* (at several levels). Monolete spores of ferns were rather abundant (17%) at 53 m, rare or absent elsewhere. These may indicate the presence of *Dryopteris thelypteris* which until recently dominated the

TABLE I

Pollen analysis of Lake Hula. Summary of counts: in per cent of total pollen and spores

Bold numbers — highest frequency, Number with asterisk — second highest frequency at each level

Depth (m)	Sediment	Frequency	Total counted	Not determined	Damaged	Centrospermae	Compositae*	Coniferae	Cyperaceae	Geraniaceae	Gramineae	Plumbaginaceae	Pteridophyta	Umbelliferae	cf. Artemisia	Butomus	Ceratophyllum	Ephedra	Lemna	Lythrum	Myriophyllum	Nuphar	Nymphaea	Olea	Polygonum	Potamogeton	Potterium	Quercus	Salix	Spartanium	Tamarix	Typha	
2-3	Grey calc. siltstone	Very poor	48	14	8	4	10*	4	4	—	4	—	—	2	4	—	—	—	—	—	—	—	—	2	34	—	—	—	4	2	—	—	1
18	Grey siltstone	Very poor	69	12	24	12	10	2	—	—	46	—	—	10	11	3	—	—	—	—	—	—	1	17	—	—	—	—	22*	—	—	—	—
31	Dark grey calc. siltstone	Good	180	12	24	7	5	1	—	—	26	—	—	6	6	—	—	—	—	—	—	—	1	—	—	—	—	3	4	14*	—	2	
43	Black peat	Good	174	11	21	2	2	3	—	—	43	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	8	26*	—	3	
49	Black peat	Poor	140	19	9	16	2	2	1	—	6	—	—	3	9	1	—	—	—	—	—	5	15*	—	—	—	—	10	—	2	—	—	
53	Dark-grey-black peat	Poor	161	11	13	26	3	2	—	—	10	—	16*	—	4	—	—	—	1	—	—	4	9	—	—	—	—	—	—	—	—	—	1
57	Dark-grey siltstone	Good	173	12	11	4	2	1	5	—	50	1	—	—	1	—	—	—	—	—	—	6*	3	2	—	—	—	2	—	—	—	—	1
62	Grey, calc. bituminous siltstone	Very poor	83	14	6	8	4	7	1	—	14	—	—	—	—	—	—	—	—	—	—	21*	—	—	—	—	1	40	—	—	—	—	—
65	Grey, calc. bituminous siltstone	Good	144	21	6	4	4	1	1	—	26*	—	—	—	—	—	—	2	1	1	2	—	10	11*	—	—	—	11*	—	—	—	—	1
71	Brown-black finegrained peat	Good	215	14	20	7	1	1	—	—	17	13*	—	—	1	3	—	—	4	—	2	—	1	2	—	—	1	1	—	—	—	—	—
82	Fine cuttings of black peat	Poor	90	12	18	9	1	1	1	—	23	—	—	—	—	—	—	—	2	—	—	2	2	3	—	1	—	21*	—	—	—	—	—
85	Black peat	Poor	127	12	13	—	2	6	—	—	10	—	1	2	11*	—	1	—	—	—	—	—	4	—	—	—	—	40	1	—	—	—	—
91	Light-grey argillaceous siltstone	Good	186	4	8	4	16*	—	1	3	24	—	—	—	3	3	5	—	—	—	—	1	—	—	—	—	—	—	5	1	—	—	1
93	Light-grey argillaceous siltstone	Good	159	13	16	14	2	—	1	—	21	—	—	—	5	1	—	—	—	—	—	—	1	—	—	—	—	19*	—	—	—	—	1
96	Light-grey argillaceous siltstone	Good	246	11	16	11	12*	1	6	—	26	—	—	—	3	1	1	—	—	—	—	—	—	2	—	1	—	10	—	1	—	—	—
100	Light-grey argillaceous siltstone	Good	168	18	5	5	4	1	—	—	25*	—	5	2	2	—	—	—	—	—	—	1	—	—	—	—	—	29	3	—	—	—	—
107	Light-grey argillaceous siltstone	Poor	174	18	10	28	8	8	3	—	11*	—	—	2	2	—	—	—	—	—	—	—	—	—	—	2	—	6	—	1	—	—	—
113	Light-grey argillaceous siltstone	Very poor	81	6	10	1	3	1	1	—	53	—	12	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	1
118	Light-grey argillaceous siltstone	Poor-good	178	20	7	3	2	12	1	—	13	1	1	2	1	—	—	—	—	—	—	2	—	1	—	—	—	35	1	—	—	—	—

* cf. *Artemisia* excluded.

undergrowth of the *Cyperus papyrus* association which predominated in a large part of the swamp.

At 71 m and to a lesser degree at 43, 49 and 53 m, there are numerous spherical bodies with short spines, tubercled, very slightly dotted or smooth. These resemble pollen grains in some points, and the almost smooth grains bear a striking resemblance to the inaperturate pollen of *Cupressus*. However, several characters, such as the smooth-edged fracturing of these grains, indicate their chitinous nature. At 71 m these cells total more than half the number of pollen grains. Their exact determination was not possible.

DISCUSSION

The two salient points arising from this investigation are the extreme scarcity of pollen grains, and the low percentage of tree pollen. These results are presumably correlated with the fundamental difference prevailing to this day between the "classical" localities of pollen analysis and the conditions prevailing in the region of Lake Hula. In the latter, trees generally, and anemophilous trees in particular, may never have formed a complete cover. For this reason the computation of pollen spectra on the basis of total tree pollen (TTP) = 100%, which in any case is impossible owing to the almost complete absence of tree pollen at some levels, does in fact lose its validity. At the present stage, at least, the total number of grains counted must, therefore, serve as a basis for the computation of pollen spectra. In spite of the temptation to do so, no pollen diagram is included. The vertical distances between samples are too big and though indicating certain trends, such a diagram would miss most peaks, inflections and nodal points which alone lend pollen analytical investigations their real value as tools in the study of past vegetation and climate.

The (former) Lake Hula lies on a very steep N-S ecological gradient, unlike anything known in Europe, involving rainfall, temperature, etc. Descending from the rainy peaks of Lebanon with some 1,500 mm of rain annually, one reaches the Jordan Valley with 582 mm at Dafna (33°14' N, + 150 m) decreasing gradually to 162 mm at Jericho (31° 51' N, — 260 m), 54 mm at the southern end of the Dead Sea (31° 04' N, — 385 m) and to less than 25 mm at Eilat (29° 33' N, + 2 m) (Climatological normals 1952). There is every reason to believe that this gradient, restricted to 4° of latitude within only 30' of longitude, has persisted throughout the Pleistocene (Willet 1953, Butzer 1957). Therefore, any point along this line must be expected to be highly sensitive to latitudinal shifts of climatic belts as reflected by changes in vegetation.

On the other hand, Lake Hula has the disadvantage of being situated in a depression surrounded by rather steep hills. Thus, the peak of Mt. Hermon at 2,800 m is only 40 km away to the N-NE, while to the west the edge of the steep eastern escarpment of the hills of Galilee, some 800 m above sea level, is only 5–10 km away. The latter seem to be of greater weight than the much higher Lebanon range as they are nearer and in the direction of the prevailing winds.

Summing up, because of the unique circumstances under which the deposits of Lake Hula seem to have formed, the classical methods of pollen analysis are not suitable. Yet owing to the geographical situation and the extent of the deposits their study is of great interest, and the present preliminary report leaves no doubt about the feasibility of such a study. To this end a continuous core is essential; two cores, for comparison, would be preferable. Flotation of some sort is recommended as a means of obtaining samples with a reasonable concentration of pollen grains.

The study of any other suitable deposits in the Near and Middle East would of course greatly enhance the value of an investigation of Lake Hula for, as shown by workers in Central and Northern Europe, the proper study of past climates and vegetation requires regional cooperation.

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THE EFFECT OF IRRIGATION WITH SALINE WATER ON THE YIELD AND SUGAR CONTENT OF FORAGE AND SUGAR BEET

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ABSTRACT

The possibility of utilizing saline water in irrigation of sugar and forage beets was investigated experimentally. Treatments conducted in field plots consisted of irrigation with NaCl and KCl solutions.

Saline irrigation was found to prevent the infection of the beets by *Physoderma leproides* (Trabut) Karling. No decrease in yield resulted from irrigation with the salt solutions. Furthermore, under these very treatments, higher percentages of sugar were found in sugar beet.

INTRODUCTION

Irrigation with saline water is one of the major problems in arid regions, where the large quantities of saline water available are left without any agricultural use. Following the publications of L. Bernstein and Ayers (1953), L. Bernstein and Pearson (1956) and Bower, Moodie, Orth and Gschwend (1954), we tried to investigate the possibilities of irrigation with saline water and its effect on the yield, the sugar content and the resistance against *Physoderma leproides* of forage and sugar beets. This fungus (R. Bernstein 1957) attacks the root crown of the beet, resulting in large galls on the root crown as well as on the leaves.

EXPERIMENTS AND RESULTS

The experiments were conducted during 1957–58 with forage beet only and during 1958–59 with both forage and sugar beets. The beets were sown in pots filled with sand. In the first year of the experiments, during the two weeks following germination, sporangia of *Physoderma leproides* were applied to the pots daily, in order to learn the effect of the various treatments on the resistance of the seedlings. During this period the pots were irrigated twice daily with NaCl solutions in concentrations of 0.1 M and 0.2 M. Control pots were watered with tap water (up to 400 mg Cl⁻

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per litre). The seedlings were subsequently transplanted to field plots and irrigated with tap water only. After three months, the beets were weighed and the percentages of the diseased plants recorded. The results are given in Table I.

TABLE I
*The effect of irrigation with saline water on yield and resistance of
forage beet to the attack of Physoderma leproides*

Treatment	Mean weight of beet in kg	% diseased plants
0.1 M NaCl	1.87 \pm 0.32	0.0
0.2 M NaCl	1.79 \pm 0.56	0.0
Control	1.83 \pm 0.24	21.0

In the second experiment, both forage and sugar beets were grown and irrigated with NaCl or KCl solutions of 0.1 M or with tap water, during the entire growing season. The soil around the plants, which received the saline treatments, was leached twice monthly with large amounts of water, in order to prevent accumulation of salts over the desired level.

The experiments were conducted in two replications, consisting of about 70 plants each. Out of each treatment, two samples, each consisting of 20 kilograms fresh material, were taken for fresh weight, dry weight and percentage sugar determinations. The results are given in Table II.

TABLE II
The effect of irrigation with saline water on yield, water and sugar content of forage and sugar beet

Treatment	Mean weight of beet in kg	% water in fresh beet	Mean % sugar content
<i>a. Forage beet</i>			
0.1 M NaCl	1.60	82.9	11.30
0.1 M KCl	1.81 } *	82.0 } *	12.25 } *
Control	1.61	83.5	12.20
<i>b. Sugar beet</i>			
0.1 M NaCl	1.09	80.8 \pm 1.10	19.05 \pm 0.24
0.1 M KCl	1.10 } *	79.1 \pm 0.28	19.00 \pm 0.20
Control	0.98	77.1 \pm 0.70	17.45 \pm 0.50

* No significant difference between the various treatments.

CONCLUSIONS

In view of the above results, the following conclusions may be drawn:

1. No decrease in yield resulted from irrigation with salt solutions. Moreover a slight trend toward an increased yield was observed, though not statistically significant.
2. Forage beet seedlings irrigated with salt solutions were not infected by *Phytophthora leproides*.
3. Under saline irrigation higher percentages of sugar were found in sugar beet.
4. An increase in water content resulted from saline irrigation of sugar beet. No such phenomenon was observed in forage beet.
5. No differences were found between the effect of NaCl or KCl on the yields and sugar content of the beets.

As these experiments are preliminary and conducted only on a small scale, it is obviously impossible to transfer their results straight to field conditions, but further investigation in this direction is promising.

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NOTES

Germination of the seeds of *Saccharum aegyptiacum* Willd.

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Planting of various *Saccharum* varieties is a common practice in the prevention of soil erosion^{1,2}. *Saccharum aegyptiacum* Willd. is one of the plants used for dune fixation³. The propagation of this plant is usually done by cuttings. In Israel an attempt was made to use this plant for the same purpose, but it was thought that propagation by seed may be more convenient. However the seeds did not germinate under the natural conditions prevailing in the coastal plain of Israel. An investigation was, therefore, undertaken to determine the conditions required for germination.

Dehusked and non-dehusked caryopses were germinated in Petri dishes on filter paper at various temperatures. They were kept either in continuous darkness or in continuous light. The germinated seeds were counted after 72 hours incubation in the various temperatures. The results are summarized in Table I.

TABLE I
*Germination percentage of Saccharum aegyptiacum caryopses
at various temperatures in darkness and in light*

Temperature (°C)	Dehusked		Non-dehusked	
	Light	Darkness	Light	Darkness
37	90	76	20	14
30	88	60	14	10
26	58	0	6	0
23	28	0	0	0
20	20	0	0	0
15	0	0	0	0

These results show that rather high temperatures are required to facilitate adequate germination. In continuous light the germination percentage is much higher than in the dark, the effect of light being especially marked at the lower temperatures, which

by themselves are unfavourable for germination. Dehusking improves germination very considerably; dehusked caryopses which had been kept at 15°C for ten days, with or without illumination, germinated up to 92 per cent in 24 hours when transferred to 37°C in light, while the non-dehusked caryopses did not germinate when subjected to a similar treatment.

As dehusking is very inconvenient in practice, various pre-treatments were tried for improving germination of non-dehusked caryopses in the dark. Thiourea and kinetin had no effect, while gibberellic acid was effective only with dehusked caryopses. A pre-treatment which proved most effective consisted in soaking the caryopses for 24 hours in water under continuous illumination at 37°C, then drying them at room temperature. The dry caryopses were sown in the greenhouse in flats filled with moist sand. This procedure resulted in germination of up to 60 per cent which is sufficient for practical purposes.

The moist sand flats were covered for the first 5–8 days with plastic covers to ensure humid atmosphere. Later the covers were removed but the flats were watered excessively until the plants grew a little.

The seeds used in these experiments were harvested from plants growing on sand dunes in the Haifa Bay region. The yields were very low, as most of the panicles did not bear fruit.

My thanks are due to Dr. Zuriel and the Ministry of Agriculture who brought the problem before me, and to Miss N. Krishmaro for technical assistance.

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The effect of coumarin on growth and respiration of *Chlorella*

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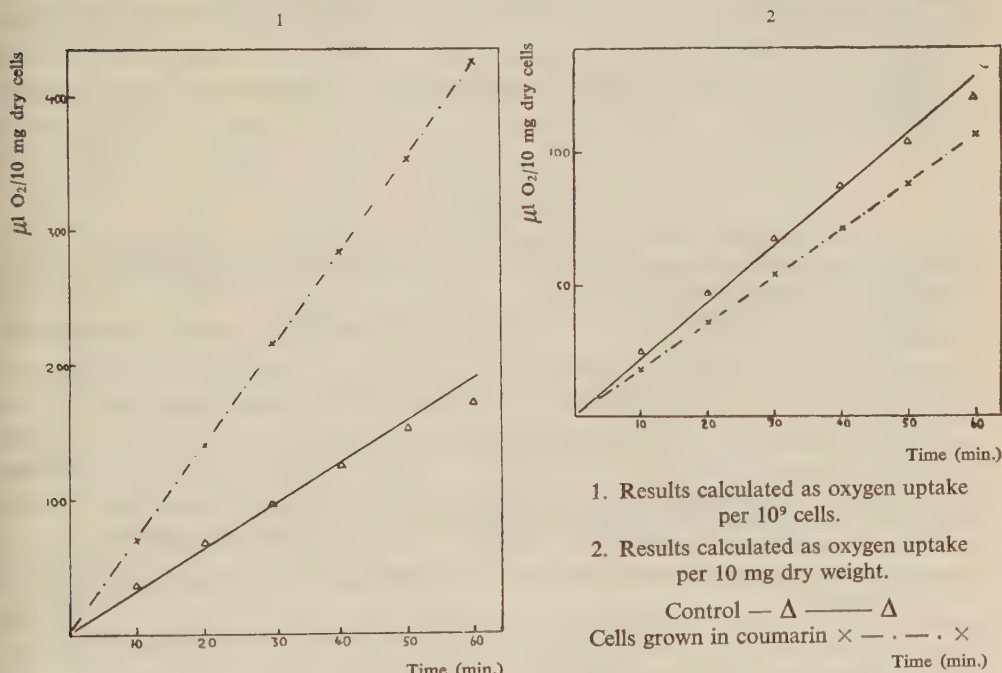
Coumarin has been widely studied because of its properties as a germination inhibitor (Sigmund 1914, Mayer and Evenari 1952, Mayer 1953). It is generally regarded as being a naturally-occurring growth inhibitor in plants, and in addition may in certain cases have growth stimulatory properties (Neuman 1958). The mechanism of its action is not understood, though it has been claimed that it affects mitosis (Corman 1946), sulphhydryl enzymes (Thimann and Bonner 1949) and phosphorylation (Leninger 1956). Its influence on the germination of uredospores has been described (Van Sumere et al.

1957), but its effect on unicellular organisms, and particularly on algae, has not been studied. It seemed of interest, therefore, to investigate its effect on a unicellular alga.

Chlorella vulgaris, strain Hopkins, was used throughout the experiments. It was grown in Roux bottles on a shaking device in the modified Knop's medium described by Sorokin and Myers (1957), at 23–29°C and at a light intensity of 300 f.c. An air-stream containing 5% CO₂ was passed through the cultures. Growth was determined by direct cell counting using a haemocytometer, and by dry weight.

It was found that coumarin, in concentrations of $1.37 \times 10^{-3}M$ and higher, inhibited the growth of *Chlorella* as expressed in cell number. At $6.85 \times 10^{-4}M$ it did not depress increase in cell number, but produced cells appreciably larger than those of the control. The mean diameter of the cells grown in coumarin was 6.8μ as compared with 5μ in the control. The effect on growth was reversible, the cells developing normally when transferred to a culture medium without coumarin.

Pearsall et al. (1937, 1940) have shown that *Chlorella* grown in the presence of 1% glucose develops heterotrophically. The addition of 1% glucose to the medium in the



Figures 1 and 2

The effect of culturing *Chlorella vulgaris* in the presence of $1.37 \times 10^{-3}M$ coumarin on the oxygen uptake of the cells. The cells were harvested and resuspended in culture medium without coumarin and their oxygen uptake measured. The vessel contained 1.75 ml algal suspension.

present investigation did not counter the inhibition brought about by coumarin, suggesting that the latter is not due to interference in the formation of carbohydrates.

When coumarin was added to the cell suspension immediately before the experiment concentrations of 6.85×10^{-3} — 2.26×10^{-4} M brought about a slight but definite increase (of the order of 20%) in the rate of O_2 uptake, as based on cell number. If the cells had been cultured in 13.7×10^{-3} M coumarin, and were then harvested and resuspended in culture medium without coumarin, their rate of oxygen uptake per cell was still higher than that of the control (Figure 1). Considered as a function, not of cell number but of dry weight or volume, however, the rate of O_2 uptake was considerably lower in the case of the coumarin cells (Figure 2).

The results reported here point to a marked effect of coumarin on the growth of *Chlorella*. This effect seems to be related to cell division, relatively low concentrations being active. Whether nuclear division itself, or the separation of daughter cells was involved could not be determined. The marked effect of coumarin on cell size at concentrations at which it does not inhibit increase in cell number may be of practical importance. The economic feasibility of mass culture of *Chlorella* is determined, among other things, by the ease of separation of the cells from the medium (Mayer, Eisenberg and Evenari 1956). An increase in the size of cells due to coumarin treatment may facilitate separation.

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The effect of light and gibberellic acid on the elongation of lettuce hypocotyls

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It has been previously shown that gibberellic acid (G. A.) stimulates the elongation of hypocotyls of lettuce seedlings¹. In the dark the stimulation was always on the border of statistical significance, while in the light it was significant. Red light of low intensities was sufficient to cause this change in significance. Various workers^{2,3} have shown that the stimulation of G. A. is affected by light. It was decided to further study the effect of light and its spectral colour on the elongation of lettuce hypocotyls in the presence of G. A. Imported lettuce seeds variety Grand Rapids were germinated in G. A. $2.9 \times 10^{-5}M$ for 24 hours at 20°C in the dark. This ensured rapid and complete germination and avoided variability due to effect of light on germination. After 24 hours the seedlings were transferred to 26°C and either kept in the dark or exposed to coloured light during the second 24 hours of their growth. After exposure they were returned to the dark, and the hypocotyls were measured 24 hours later, i.e. 72 hours from the time of placing the seeds in the solution. Controls in water were similarly treated. The results are summarized in Table I. These data, contrary to previous results, show that G. A. $2.9 \times 10^{-5}M$ very significantly stimulated the elongation of lettuce hypocotyls in the dark (Table I). But the experimental treatment in these experiments differed from that previously reported¹. In addition, in the present experiment each individual measurement was taken into consideration during statistical analysis, with the result that the significance of even small differences between treatments could be ascertained, while previously only replicate means were considered. All the hypocotyls given G. A. in the light were significantly longer than those treated with water. The light doses for the different filters were chosen so that the total amount of light transmitted (as calculated from total transmittance data of the filters) was the same. Table II gives the transmittance data of the filters. Table I shows that in water the data fall into two homogeneous groups: 1) dark, red OR2, green OGr1 and blue OB10, 2) red OR1. Red light passing through this last filter (OR1) significantly depressed elongation of the hypocotyls in water. For seeds treated with G. A. the data fall into two different groups: 1) red OR2, blue OB10, dark and red OR1, 2) green OGr1. This suggests interaction of light and G. A. in their effect on hypocotyl elongation. Only green light markedly stimulated the elongation as compared with the corresponding dark G. A. control.

The fact that not only red light but other colours were effective, in no way suggests the existence of the well known R-FR (Red-Far Red) light effect^{4,5,6} which was previously investigated¹, and FR was shown to partially reverse G. A. stimulation in germination¹. It was therefore decided to see whether FR light could reverse

the stimulatory effect of G. A. on hypocotyl elongation. Seeds were germinated as before in water or G. A. at 20°C in the dark for 24 hours and then transferred to 26°C. They were then treated with R or FR light, obtained by wrapping the Petri dishes in red cellophane paper (R) or in blue and red cellophane paper (FR), (see Table II), and illuminated for 3 hrs with 180 f.c. of white light falling on the wrapped Petri dishes. The red paper transmitted R and FR light while the blue and red paper transmitted only the FR. The results are given in Table III. The hypocotyl lengths in all the treatments given in the presence of G. A. are significantly greater than the corresponding ones in water. Within each treatment, water or G. A., the results fall into homogeneous groups. In water three groups are observed: 1) dark, 2) R + FR 3) R, and FR + R. In G. A. four homogeneous groups appear: 1) dark and FR, 2) R, 3) FR + R, 4) R + FR. This change in the number of homogeneous groups suggests again the existence of an interaction of G. A. and light. FR did not reverse the elongation caused by G. A. In water all the illuminations depressed elongation, the light here therefore corresponding to OR1 in Table II. The sequence FR + R depressed more than the reverse one R + FR, showing that not only the colour of light given but also the order in which it is given is of importance. In G. A. all the treatments containing R depressed the elongation.

TABLE I

The effect of G.A. and light on the elongation of lettuce hypocotyls (the filters used were Chance glass filters of the type indicated by the letter and number under treatment)

Treatment	Water			G.A. $2.9 \times 10^{-5}M$		
	\bar{x}	s.d.	<i>n</i>	\bar{x}	s.d.	<i>n</i>
Dark	8.6	2.9	128	10.3	3.96	183
Red OR2	8.4	2.0	44	10.8	4.80	43
Green OGr1	7.9	4.0	44	12.3	3.30	46
Blue OB10	7.7	2.7	36	10.5	3.00	46
Red OR1	5.0	2.4	28	9.3	6.20	42
Standard error of sample means		0.446			0.584	
Lowest significant difference between sample means*		1.042			1.362	

\bar{x} = sample mean of hypocotyl length in mm.

s.d. = standard deviation of sample values about sample mean.

n = number of seedlings in sample.

*Every difference between means for water treatments which is larger than 1.042 and every difference between G.A. treatments larger than 1.362, is considered significant at the level of $P = 0.05$.

All the differences between water and the corresponding G.A. treatment in dark and in light were significantly different at $P = 0.01$.

TABLE II
Transmission data of filters used

Filter	λ maximum transmission (Å)	λ transmission range (Å)
OGr1	5300	4500—6100
OB10	4300	3400—5100
OR1	above 6700	6200 and above
OR2	above 6300	5800 and above
Red cellophane (R)	above 6500	5900 and above
Red + blue cellophane (FR)	Transmission rising from 6500—8000	

caused by G. A., while FR alone did not. A suggestion of this effect will also be found in Table I, where OR1 was lower but not significantly so than dark. FR alone does not reverse the effect of G. A. Red does so to some extent, as do combinations of R and FR. Similar effects of R + FR have been noted in the germination of lettuce¹, as well as in growth of leaves⁷.

These results are in accord with those of Vlitos and Meudt² and Lockhart³ who showed that G. A. reverses the growth inhibition caused by light. It is particularly interesting to note that green light, usually regarded as inactive, increased the effectiveness of G. A. in stimulating the elongation of hypocotyls. Also the FR used here under the conditions described depressed elongation.

To sum up, G. A. stimulates the elongation of hypocotyls. Green light is particularly effective in promoting such stimulation. G. A. appears to reverse the light

TABLE III

Effect of Red (R) and Far Red (FR) illumination on the elongation of lettuce hypocotyls in the presence and absence of G.A. $2.9 \times 10^{-5}M$

Treatment	Water			G.A.		
	\bar{x}	s.d.	<i>n</i>	\bar{x}	s.d.	<i>n</i>
Dark	8.2	2.6	76	10.65	3.6	88
R + FR	5.2	2.6	163	7.3	4.5	179
FR	5.1	2.7	73	10.40	3.8	90
R	4.6	2.9	86	9.70	3.5	93
FR + R	3.5	2.2	89	8.80	4.8	91
Standard error of sample means		0.275			0.171	
Lowest significant difference between sample means		0.642			0.399	

Symbols as in Table I. All the differences between treatment in water and corresponding treatment in G.A. were significant at $P = 0.01$. Significant difference between sample means as in Table I.

inhibition of elongation. G. A. and light appear to show interaction in their effect on hypocotyl elongation.

Our very sincere thanks are due to Mr. S. Zacks, Technion-Israel Institute of Technology Haifa, for his assistance and advice in the statistical evaluation of the results.

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The influence of sandstorms in the Negev on the sensitivity of potatoes and tomatoes to the early blight disease

J. ROTEM, *Faculty of Agriculture, The Hebrew University, Rehovot and Department of Plant Pathology, Agricultural Research Station, Rehovot*

Early blight disease of potatoes and tomatoes which is caused by the fungus *Alternaria solani* (E. et M.) Jones et Grouet appears in most parts of Israel without causing serious damage to plants. This disease assumes a serious form, however, in the arid and semi-desert parts of Israel, particularly in the northwestern Negev, where leaves and plants are totally dried up.

We have found that the principal cause of the serious damage due to this fungus in these parts of Israel are the sandstorms which occur in this region during the autumn and early winter. This fact was discovered and verified by means of observations and by field and laboratory experiments, including artificially produced sandstorms.

A correlation was found between the occurrence of the disease and the frequency of sandstorms in various parts of the country. The worst epidemics occur in those agricultural regions where sandstorms are the strongest and most frequent, namely, in the Gilat, Urim and Mivtachim areas (Figure 1). The intensity of both the sandstorms and disease decreases gradually as one approaches the Mediterranean coast. In the coastal belt proper, where sandstorms do not occur, early blight disease manifests itself as single leaf spots, which do not cause serious damage to the plant. Furthermore, in the spring the disease appears rarely in the northern Negev where few sandstorms occur during this season.

The influence of sandstorms on the development of early blight in tomatoes and potatoes is due to mechanical injury to the plant tissue. This was demonstrated by



Figure 1
Tomato leaf after a strong sandstorm. Mivtachim, 7.1.1959.

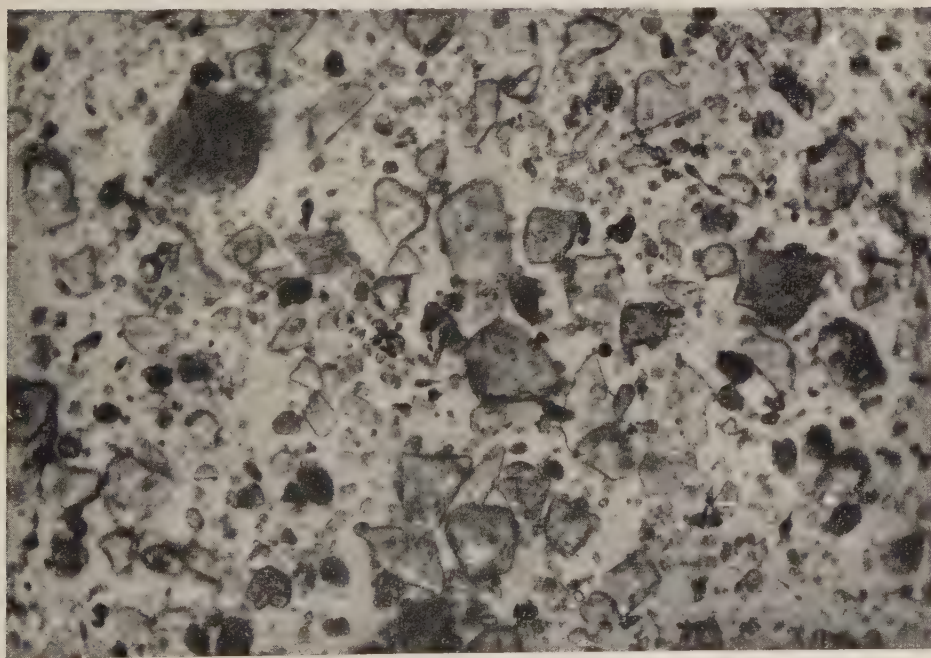


Figure 2
Sand accumulated on vaseline-coated chart of dust trap. Mivtachim 7.1.1959, 11 o'clock,
times 100) (magnified 100 times)

means of inoculations carried out on uninjured leaves as well as on leaves whose tissue had been injured. It appears that while *A. solani* is capable of penetrating uninjured plants, the efficiency of penetration is many times as great in the case of injured tissues.

A simple and convenient method of estimating the extent of mechanical tissue damage was found. Tomato and potato leaves, similar to citrus fruit¹, showed mechanical injury invisible to the naked eye by turning red upon 12–24 hour immersion in 0.1 % 2-3-5 triphenyl tetrazolium chloride. Uninjured leaves on the other hand, did not undergo any change of colour. For instance, leaves of potato and tomato plants grown in the northern Negev turned entirely red, whereas those of the coastal belt showed little colour change.

In the meteorological part of this work, we attempted to find some pattern of occurrence of sandstorms in the northern Negev. As was mentioned above, they occur mostly during the autumn and winter, and generally appear at a time when rains begin to fall further north. These rains usually reach the Negev after a lag of a number of hours or days, and sometimes do not appear at all. However, even when rain does not reach the area, as a rule, the sandstorms are followed by a few nights of heavy fog or dew precipitation. The combination of sandstorms followed by rain, fog or dew, has great epidemiological influence on the development of early blight disease.

At present, a method of quantitative characterization of sandstorms is being developed. It is based on the use of a volumetric dust trap first described by Panzer, Tullis and Van Arsdell², and modified by us. This trap effectively catches airborne dust and sand particles which stick to the vaseline-coated chart of the trap and thus provide an accurate indication of airborne solids. These charts are photographed (Figure 2) and from a large number of such photographs it is possible to devise a standard scale as an aid in defining various degrees of intensity of sandstorms..

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PROCEEDINGS OF THE BOTANICAL SOCIETY OF ISRAEL
AT THE THIRD CONVENTION OF SCIENTIFIC SOCIETIES
OF THE
ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE IN ISRAEL
Held in Haifa, October 19—21, 1959

First Session, Monday afternoon 19.10.59

Chairman: E. SHMUELI

Plant-Water-Soil Relations (A)

Soil factors determining soil water properties

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Soil moisture energy status and soil moisture mobility are of considerable interest to botanists.

Understanding of soil moisture energy status may be enhanced by studying the factors, which influence it. Based on measurements taken in some Israel soils, the influence of adsorption, diffuse double layer, capillarity and dissolved substances on soil moisture energy level is discussed. More recent ways of characterizing soil moisture mobility and methods used to determine this property and involving the concept of diffusivity are described. Role of soil pore geometry in determining it is demonstrated, and explained.

Biological significance of the soil moisture properties under consideration is also briefly discussed.

On the hydro-ecological relations of the vegetation in the Near Eastern deserts

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1. The deserts of the Near East belong to three phytogeographic regions: the Saharian, Turanian and Nubo-Balutchian. Hydroecologically they can be subdivided into 'rain deserts' and 'runoff deserts'. The former denotes these parts in which the amount of rainfall is still sufficient to support plant life throughout, whereas runoff deserts are abiotic and harbour vegetation only in depressions and wadi beds, which are fed by moisture coming from nearby catchment areas.

2. The sublethal amount of rainfall in rain deserts ranges between the 100 mm and 50 mm of annual average. It varies with soil structure and air humidity of the area.

3. Hydroecological properties of desert plants manifest themselves within the sublethal zone of rain deserts and not within runoff habitats which may eventually support plants of even mesophytic character. Unfortunately, much of the hydroecological information of desert plants stems from the latter habitats; hence contradiction and confusion ensue as to the data on water balance in deserts.

4. Many morphological and physiological properties characteristic of desert plants occur also elsewhere under milder life conditions, but these properties become very efficient in balancing the water economy of plants when they manifest themselves at or near the extreme ends of their ranges.

5. In the Near Eastern deserts, as also in other deserts, plant life is hydroecologically balanced by the following means:

a) Prevalence of life forms adapted to desert conditions. In the biological spectrum there is an extreme numerical reduction of biseasonal life forms. The number of winter annuals, cryptophytes and winter hemicryptophytes, distinct by their short, rather mesophilous life cycle, amounts to 80%. The remaining 20% are chamae- and phanerophytes as well as therophytes and biseasonal hemicryptophytes.

b) Presence of morphological, anatomical and physiological properties which act either towards the increase of moisture intake or the decrease of water output. The first group comprises (1) configuration and plasticity of roots, (2) increase of seasonal or perennial osmotic pressure of the cell sap, (3) ability of plants to absorb atmospheric humidity by aerial organs. The second group of adaptational features includes all those properties which control transpiration, i.e. xeromorphic plant structure, regulation of stomatal movements and especially seasonal reduction of transpiring surface.

c) Features enabling plants to endure long periods of drought either by tolerating high saturation deficits without interruption of physiological activities or by assuming a state of perennial latency with a complete standstill of any physiological activity.

The calculation of crop water requirements from meteorological data under semi-arid conditions

G. STANHILL, *Division of Irrigation and Soil Technology, Agricultural Research Station, Rehovoth*

Much interest has recently been aroused by the calculation of evapo-transpiration from agricultural crops using meteorological data, as saving time, equipment and labour and giving the possibility of extrapolation over large areas and for different years. When the values have been computed they are balanced against rainfall, irrigation and available soil moisture so that the current soil moisture and hence irrigation requirements, can easily be calculated. The majority of evaporation formulae with a

sound physical basis have been developed or tested in humid regions or under conditions of non-limited moisture supply. However, because of the special problems of arid regions, further investigations are urgently required. A number of both physical and empirical formulae have been compared with measured evaporation and evapotranspiration at Gilat in the Northern Negev and the results will be reported. Also the possibility of replacing the calculations by the use of simple atmometers will be discussed.

Transpiration reduction by spraying with low viscosity silicones

H. BIELORAI AND D. ANGUS*, *Agricultural Research Station, Rehovoth*

Considerable interest has recently been shown in the reduction of evaporation from water surfaces by monomolecular films. Since worthwhile conservation of water is possible, can similar savings be obtained if transpiration will be reduced by appropriate treatment of plant foliage?

The chemical at present in general use on water surfaces is cetyl alcohol. Under special conditions the film is destroyed quite rapidly. (The most likely explanation is attack by microorganisms.) However, excellent results have been obtained by using low viscosity silicones. These are built up of dimethyl polysiloxane chains, the viscosity being determined by the length of the chains.

More than 20 substances were first tested on water surfaces, in the greenhouse, and those that had any effect on evaporation were then tested on sunflower plants (*Helianthus annuus*, variety 'advance'). Each substance was sprayed onto four replicate plants with an atomizer, but in a few treatments the leaves were dipped in the liquid. There was an appreciable reduction in transpiration from the plants treated with cetyl alcohol. This was caused, however, by considerable damage and stunting of plants. The only other substances which had any appreciable effect in reducing transpiration rates were the low viscosity silicones (40 and 50 centistokes). A slight leaf deformation appeared occasionally. The apical meristematic tissue exhibited the greatest deformation. In one treatment the apex was protected from contact with the silicone, and remained normal. The ratio of the transpiration from the treated plants, to that from the controls varied considerably from trial to trial and from day to day.

Immediately after a spray application, the ratio of the transpiration rates was reduced considerably. It then rose over a period of a few days and levelled off to a value still significantly below the value in the control.

It can be concluded from this work that a low viscosity silicone has a significant effect in reducing transpiration from sunflower plants. Whether this is due simply to a film effect, as in the case of water surface, or to biophysical and biochemical effects on the physiology of the plants, is not yet known.

* D. Angus, scientist of the University of California, Davis, Calif. where this work was carried out.

The silicone may have a biophysical effect by interfering with normal oxygen and carbon dioxide exchange.

The silicone may also have a biochemical effect by moving through the cell wall system and disrupting the organization of the membranes of individual cells.

It could affect the metabolic activity of the protoplasm.

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Second Session, Tuesday morning 20.10.59

Chairman: G. ORSHAN

Plant-Water-Soil Relations (B)

Plant-water relationships

E. SHMUELI, *Division of Irrigation and Soil Technology, Agricultural Research Station, Rehovoth*

The investigation of plant-water relationships has received much attention in the last decade ^{1,6}, and the *osmotic relationships in the plant cells* have been extensively discussed. There is a growing tendency to describe these relationships in terms of the free energy balances in the system. One of the ways to describe the free energy of the water in the vacuole is the formula due to Meyer ⁵:

$$\text{DPD}_{\text{in}} = \text{OP}_{\text{in}} - \text{TP}.$$

Here DPD_{in} is the diffusion pressure deficit of the vacuole with respect to pure water, which expresses the specific free energy of the vacuole water; OP_{in} is the osmotic potential of the vacuole sap; and TP is the turgor pressure. The specific free energy of the medium surrounding the vacuole, which is determined by the osmotic potential of the medium (OP_{ex}) and by other effects (such as moisture stress), can also be expressed as a diffusion pressure deficit with respect to pure water (DPD_{ex}). The direction of diffusion is determined by the balance between DPD_{in} and DPD_{ex} ; if DPD_{in} is larger than DPD_{ex} , water will pass from the medium to the cell, and vice versa.

Philip ⁷ has lately attempted to derive an exact mathematical expression for the dynamics of the osmotic process. He showed, e.g., that in a cell surrounded by pure water, in a state of incipient plasmolysis and with membranes permeable to water only, the process follows an exponential curve, and reaches an equilibrium determined

by the initial osmotic potential and by the elasticity of the cell wall. The factors determining the rate of approach to this equilibrium are, in addition to the two mentioned above, the initial cell dimensions and the permeability of the membrane to water. The mathematical treatment, which is based on the assumption of a simple classical osmometer model, is easily generalized to states of any initial turgor, a medium other than pure water, and membranes permeable to some of the solutes. In so far as Philip's basic assumptions are close enough to the real conditions in the plant, his formulae make possible the precise evaluation of the amount which will diffuse into the cell, the rate of diffusion, and the changes in turgor. There is an interesting correspondence between Philip's theoretical formulae and the changes in water intake and the rate and rigidity which were determined by Virgin⁸ using his new method of measuring turgor changes.

Bogen⁵ postulates, in addition to the osmotic process, also the existence of metaosmotic and active intake processes, the first resulting from changes in the state of water in the plasma, and the second involving metabolic energy. From the practical point of view, the differentiation between osmotic and metaosmotic intake does not seem to be useful at this stage, because no direct method of measuring the specific free energy of plasma and cell wall water has yet been devised. As to the active (metabolic) intake, there is no direct proof of its existence. The fact that plasmolytic measurements of osmotic pressure usually yield higher values than cryoscopic determinations is not enough to establish the existence of active intake, and the observed discrepancy is apparently due to the specific limitations of each of the two methods of measurements.

As to the methodology of measuring diffusion pressure deficits, it is worthwhile to mention the methods of Arcichovskij⁹ and Ashby and Wolf¹⁰. These methods are being intensively investigated in U.S.S.R.³ and in this country, and there may be a possibility of using them under field conditions. An important development in measuring DPD can be envisaged starting from the new methods of Spanner¹¹ and Slatyer¹², in which the DPD is measured by vapour equilibrium determination. These methods are particularly useful when the DPD is considerably larger than the OP of the cell sap.

In the absence of a method of expressing the *water condition in terms of the entire plant* as an integrated unit, investigators continue to determine separately the osmotic conditions in the various parts of the plant. In this context, one should beware of oversimplified generalizations, such as Walter's concept of "Hydratur." The investigation of the water condition in the plant as a whole unit has become even more urgent after Veihmeyer's theory^{1,5} was shown to be valid, apparently, only in exceptional cases. It has been shown that under arid and semi-arid conditions the optimum soil moisture range does not extend all the way from field capacity to wilting point, but only above a certain critical region. This region appears to depend both on the plant species and on environmental conditions, and it is there-

fore necessary to base its investigation on a detailed understanding of the plant's response to specific conditions.

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The response of corn and cotton to different soil moisture regimes

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Veihmeyer¹ showed in 1927 that a constant level of soil moisture cannot be maintained in irrigation experiments, and these experiments can therefore only test the plant's response to different cycles of soil moisture depletion. The responses that can be measured are, on the one hand, the cumulative effects of different moisture regimes (on variables such as yield, height, leaf area), and on the other hand, the immediate responses of the plant, at a fixed time and under uniform climatic conditions, to different soil moisture levels. Field and greenhouse irrigation experiments on corn and cotton, in which both kinds of responses were measured, are described in this report.

The immediate responses tested were opening of stomata, osmotic pressure (by cryoscopic method and by refractometric method), diffusion pressure deficit (by refractometric method and by "flow" method), relative turgor, transpiration, stem fluid concentration (by electric method), and daily growth rate. One of the main problems in testing the immediate responses is the problem of standardization² (with respect to the part of the plant tested, the time of testing, etc.). A standardized method of measurement, which emphasizes the plant's sensitivity to soil moisture depletion, and at the same time is simple enough to be easily applied under field conditions, can be used as a physiological indicator of the plant's water regime. From a practical point of view, such an indicator can be used to determine irrigation schedules. Along these lines, good results were obtained in corn and cotton with the infiltration method, using a 1:2 mixture (by volume) of paraffin and turpentine. In cotton, the refractometric test may also be used as an indicator.

Of the cumulative effects, the final yields under different irrigation schedules were compared. It was assumed that, at least as a first approximation, the daily yield increment depends mainly on the soil moisture level. Since, in an irrigation experiment, the changes in soil moisture level during the entire growth period are

recorded, it is possible to evaluate the daily growth increment as a function of the soil moisture level. This function gives a numerical expression of the yield decrease caused by any given soil moisture depletion, and can thus lead to both theoretical conclusions and practical rules for determining irrigation schedules.

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The effect of nitrogen supply and water regime on anatomical structure of corn and cotton leaves

TOVA ARZEE and Z. GLINKA, *Department of Botany, University of Tel-Aviv*

In summarizing the effect of various factors on leaf structure Stlfelt⁶ has stated that under conditions in which a significant water deficit is created in the plant there is a tendency for xeromorphic features to appear. This is expressed in an increase in vein density and stomatal frequency and a decrease in leaf size and the size of individual cells. He also comments that a deficiency of nitrogen supply influences development of xeromorphic features.

Our recent observations on epidermal structure of corn and cotton leaves have thrown some doubt on the validity of these views.

1. Epidermal structure of the leaves of corn plant grown under conditions of high and low water supply, and ample and deficient nitrogen supply were examined.* Some of the results obtained are summarized in the accompanying Table I.

TABLE I
Frequency of stomata and epidermal cells in corn leaf 3rd from inflorescence

No. of treatment	No. of irrigations	(NH ₄) ₂ SO ₄ (kg/dunam)	Condition of water regime & nitrogen supply	Upper epidermis			Lower epidermis		
				Stomata/mm ²	Epid. cells/mm ²	Ratio stomata epid. × 100	Stomata/mm ²	Epid. cells/mm ²	Ratio stomata epid. + 100
A ₁	3	0	dry-deficient	61	269	22.6	74	297	24.5
A ₄	6	0	wet-deficient	67	304	22.4	85	314	27
D ₁	3	100	dry-ample	60	331	18.1	81	352	23
D ₄	6	100	wet-ample	68	281	24.4	85	320	28.2

Statistical analysis

(sign = designates no significant difference.

A ₁ < A ₄	A ₁ < A ₄	A ₁ = A ₄	A ₁ < A ₄	A ₁ > A ₄	A ₁ < A ₄
D ₁ < D ₄	D ₁ > D ₄	D ₁ < D ₄	D ₁ = D ₄	D ₁ < D ₄	D ₁ < D ₄
A ₁ = D ₁	A ₁ < D ₁	A ₁ = D ₁	A ₁ = D ₁	A ₁ × D ₁	A ₁ = D ₁
A ₄ = D ₄	A ₄ = D ₄	A ₄ = D ₄	A ₄ = D ₄	A ₄ = D ₄	A ₄ = D ₄

* A field experiment combining fertilizer and irrigation treatment carried out by D. Shimshi at Gilat, 1958.

From the table it is apparent that the influence of water regime was more effective on anatomical structure than the nitrogen supply. The effect of water regime was generally contrary to the views held, as was summarized by Stålfelt.

2. Epidermal structure of leaves of cotton plants in pot irrigation experiment was examined*. Some of the results are summarized in Table II.

TABLE II
Leaf area, vein density and stomatal frequency and number of epidermal cells per unit area in cotton leaf

No. of treatment	Leaf-area (cm ²)	Veins (mm/mm ²)	Upper epidermis		Lower epidermis	
			Stomata/mm ²	Epid. cells/mm ²	Stomata/mm ²	Epid. cells/mm ²
1	36	8.6	92	882	275	1204
2	62	8.3	101	828	286	1120
3	71	7.8	95	810	269	1036
4	85	9.0	99	810	272	1120
5	89	7.9	86	792	260	1036
6	100	7.4	92	739	275	1008

No. 1 — indicates the driest treatment.

No. 6 — indicates the wettest treatment.

Again, it is obvious that the results presented are not in agreement with Stålfelt's statement. In spite of the high significant differences in total leaf surface in various water treatments, there were no significant differences in vein density, stomatal frequency and size of epidermal cells. It would be worthwhile, therefore, to reexamine and clarify the effect of water regime in soil and plant on the anatomical structure; furthermore, it is suggested to extend this investigation from the very early phases of leaf ontogeny up to the final development of leaf, since water regime might affect a great deal the meristematic activity period in leaf.

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* Experiment carried out in a greenhouse, Rehovot, by A. Shmueli and M. Ophir, 1959.

Effect of soil moisture level on cell wall metabolism

Z. PLAUT and L. ORDIN, *Agricultural Research Station, Rehovoth*

It has been shown that there is a correlation between plant growth and the synthesis of various cell wall constituents. Determination of biochemical changes in the cell wall should, therefore, help to clarify the mechanism of growth and the factors affecting it.

The effect of soil moisture changes on the incorporation of glucose C^{14} into the cell wall constituents of sunflower and almond seedling leaves was investigated. Plants which had been growing under different soil moisture regimes and were brought to field capacity previous to the beginning of C^{14} incorporation, showed equal incorporation. For a number of constituents there occurred increased C^{14} incorporation in those plants which had been grown under a dry soil moisture regime before the final irrigation to field capacity, in comparison to plants which had been grown at a moisture regime close to field capacity during the entire growth period.

On the other hand, plants which had been grown under a dry soil moisture regime, and were not irrigated before the incorporation of C^{14} , showed decreased incorporation on comparison to plants which were grown at a moisture content near to field capacity during the entire growth period.

Changing the critical moisture in the various stages of *Gladolus*

A. H. HALEVY, *Faculty of Agriculture, The Hebrew University, Rehovoth*

Irrigation pot experiments were carried out. The soil moisture tension in which irrigation was applied, varied in the various stages. 3 main development stages were distinguished: A. From emergence to the full extension of the 5th leaf; B. From the 5th leaf to anthesis; C. From anthesis to the end. The critical soil moisture content (CM)—which decreases yield—has been found to differ at the various stages, and according to whether the intended crop is flowers or corms. When growing for corms, the CM corresponds to the tension of 0.6 to 0.8 Atm. for stage A and C. But between the above periods, i.e. at the time of flowering stem elongation, the CM corresponds to a tension of 0.3 to 0.6 Atm. only. When growing for flowers there is a difference whether the number of flowers per stem, or its length is concerned. In regard to the number of flowers per stem, a CM corresponding to 0.3 to 0.6 Atm. is operative, from the sprouting to the full extension of the second leaf only. As for the stem length in stage A, CM is of the same as for the corm production, while in stage B it is necessary to keep very high soil moisture, as CM corresponds to tensions even lower than 0.3 Atm.

3rd Session, Tuesday 20.10.59 — 15.00—18.00

Chairman: J. GALL

Miscellaneous Varia

Phytotronics

D. KOLLER, *Department of Botany, The Hebrew University of Jerusalem*

A description is given of the Earhardt Laboratory for Plant Research, its equipment and possibilities of research in problems of environmental effects on growth processes and plant development.

Evolutionary problems in the genus *Medicago*

CHAIM C. HEYN, *Department of Botany, The Hebrew University of Jerusalem*

Most species of the genus *Medicago* belong to the sections *Falcago* and *Spirocarpos*. The morphology and cytology of many of these species were investigated, as were also their pollination mechanisms, breeding systems, fruit dispersal and geographical distribution. From the assembled data the conclusion is reached that the section *Falcago* is the more primitive and the section *Spirocarpos* should be regarded as having originated from it. Some of the species included in *Medicago* show great likeness to species of *Trigonella* and *Melilotus* and none to other species of *Medicago*. Investigation of these species and especially of the generic characters accepted by most botanists for the three genera, gives rise to doubts as to their delimitation. From the revision of the possible links between *Medicago*, *Trigonella* and *Melilotus*, it becomes evident that the bending of the pod, which is thought to be characteristic of *Medicago* should be regarded as a character which appeared a number of times in the course of the evolution of these three genera.

Weed control in sugar beet fields

M. HOROWITZ, *Faculty of Agriculture, The Hebrew University, Rehovoth*

Jurassic conifers from Makhtesh Ramon, Israel, and their relation to the Jurassic flora of the world

J. LORCH, *Department of Botany, The Hebrew University of Jerusalem*

Remnants of a conifer flora recently excavated in Southern Israel include stems, twigs, leaves and both male and female cones of several species of Jurassic conifers. Due to very favourable conditions of sedimentation cuticles are well preserved. Species so far examined belong to the genera *Cupressinocladus*¹, *Pagiophyllum*, *Brachyphyllum*, as well as one or two new genera. Attempts are made to obtain more cones and to determine the wood structure as far as possible.

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Spininess in *Ricinus* — a character determined by a mobile morphogenetic factor

HAVA STEIN, *Plant Genetics Section, The Weizmann Institute of Science, Rehovoth*

In *Ricinus*, recessive s determines absence of spines from the capsule. Ss is spiny, but number of spines is much lower than in SS . A new (iso) allele, s^f was recently found at this locus. $s^f s^f$ is spineless like ss , but in Ss^f , number of spines is much lower than in Ss . In Ss^f , the number of spines fluctuates widely according to the age of the plant and the position of the raceme. This indicates that a substance regulating spine number may be produced in the vegetative plant parts.

Colour inheritance in *Ricinus*

HAVA STEIN, *Plant Genetics Section, The Weizmann Institute of Science, Rehovoth*

The gene M (mahogany) is known to determine the presence of anthocyanin in all aerial plant parts. Gene m^g (green) was found to restrict anthocyanin distribution to young leaves, pistils and hypocotyl only. Gene m^p (pure green) determines absence of anthocyanin from all plant parts (except seeds) including hypocotyl. Therefore $m^p m^p$ plants can be identified as seedlings. Gene ag (anthocyanin glands) causes the appearance of gland-like, multicellular structures, embedded in the epidermis, in which anthocyanin accumulates. Therefore, ag acts as an intensifier of red colour. $m^p m^p ag ag$ plants are completely green when young, later red "glands" in great numbers appear on the stalks. Gene m^s (strong green) is usually similar in expression to m^p , but $m^s m^s ag ag$ plants do not develop red glands; therefore m^p and m^s are not identical, but are isoalleles. Gene T determines very early appearance of the seed coat pattern on the young ovule. In $TT Ag Ag$ plants, the pattern is traced out in yellow; in $TT ag ag$ plants, it is traced out in red. Hence, flavonols and anthocyanins are considered precursors of the phytomelans which are the pigments of the adult seed. Gene n (non-coloured) causes a decrease in amount of anthocyanin in sepals, capsules and to a lesser extent, in cotyledons. In $m^g m^g nn$ plants, which are green, n determines white versus green capsule colour, in $MM nn$ plants, which contain anthocyanin, n determines bright pink versus reddish-brown capsule colour.

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Fourth Session, Wednesday morning 21.10.59

Chairman: M. NADEL-SCHIFFMAN

Mycology

Fungi attacking nematodes

SH. COHEN, *Kvutzat Metzuba*

Effect of salt water irrigation on the pathogeneity of *Physo derma leproides* (Trab.) Karling

RUTH BERNSTEIN and Y. WAISEL, *Faculty of Agriculture, The Hebrew University, Rehovoth and Department of Botany, The Hebrew University of Jerusalem*

Physo derma leproides is known to attack forage beet. This infection results in large galls on the root crown as well as on the leaves. As forage beet is known to be resistant to relatively high concentrations of NaCl, the possibility to prevent the beet's infection by this fungus by means of saline irrigation was investigated. The assumption was that the fungus might be less salt tolerant than the beet and the results obtained so far approved it.

Cephalophora tropica Thaxter, a rare Hyphomycete isolated from seeds in Israel

CHAJA CHABELSKA-FRYDMAN, *Department of Botany, The Hebrew University of Jerusalem*

A new record of the rare tropical fungus *Cephalophora tropica* is reported. The fungus occurs on the seeds of *Trigonella arabica*, a new host to this fungus. The optimal growth of the colony on Czapek's was at 26–30°C. Production of conidia was abundant on all media used. Enzymatic activity results in the liquefaction of gelatine, utilization of starch; failure to decompose cellulose and to liquify pectin.

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The ecology of *Alternaria solani*

J. ROTEM, *Department of Plant Pathology, Agricultural Research Station, Beit Dagan - Rehovoth*

The fungus *Alternaria solani* is parasitic on a number of plants, the most important among which are potatoes and tomatoes. *A. solani* attacks aging plants. In addition to the age of the plant, there are a number of other biological factors which influence plant sensitivity to the disease.

The occurrence of the disease is not uniform throughout the country. It is particularly common in the northern Negev, and only there does it represent a limiting factor for the growth of tomatoes and potatoes.

Epidemics of *A. solani* in the northern Negev are functions of a complex of ecological factors. Some of these directly promote the development of the fungus, while others affect the degree of resistance of the plants. Among the former is night time dew which facilitates spore germination, and on the other hand the general aridity of the area which helps the fungus survive more efficiently from one season to the next. Primarily responsible for the increase of sensitivity of the plants to the disease in the northern Negev are sandstorms. Sand grains injure the plant tissue facilitating the penetration of the fungus.

Stages in the development of *Synchytrium helianthemum*

LANA LAOR (SONNENSCHIN), *Department of Botany, The Hebrew University of Jerusalem*

The fungus *Synchytrium helianthemum* from the order Chytridiales is an intercellular parasite. In Israel it attacks three species of the genus *Helianthemum*: *H. lasiocarpum*, *H. ledifolium*, *H. salicifolium*. During the rainy winter months small dark red galls appear on all the aerial parts of the attacked plants. According to our data, the fungus develops during its life-cycle, which lasts only three to four months, all forms known in the genus *Synchytrium*, i.e. prosori, sori, sporangia and resting spores, and it should, therefore, be regarded as a macrocyclic fungus. The cytology of all these forms was investigated.

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Relationships between *Pisolithus tinctorius* (Mich. ex Pers.) Coker Couch. and *Eucalyptus camaldulensis* Dehn.

RUTH NEUMANN, *Department of Botany, The Hebrew University of Jerusalem*

The interrelations between *Eucalyptus* trees and *Pisolithus tinctorius*, a Gastromycet (Sclerodermataceae), were investigated. This fungus, which appears in Israel mainly in its southern parts, has always been found as a mantle enveloping the roots of *Eucalyptus* trees, mainly *E. camaldulensis*. We did not find it around other tree species, which agrees well with the observations of Bottomley in South Africa.

Except in one case, no penetration of hyphae into the roots of the trees was observed in anatomical sections. Thus the possibility of mycorrhiza in this case is excluded, and the relationship is rather at a rhizospheric level.

Following the publications of Bjorkman¹, Pryor², Levisohn³ and Melin⁴, it was assumed that this fungus too many improve the mineral absorption by *Eucalyptus* trees. This seemed to be of major importance, especially as the lime-induced chlorosis in *Eucalyptus camaldulensis* is caused by difficulties in iron nutrition⁵. Moreover, most of the well developed and non-chlorotic trees in Gevulot region, are associated with *Pisolithus*, while this fungus was not found under chlorotic trees.

In a series of experiments, the effect of a living mycelium of *Pisolithus* on the growth of *Eucalyptus* seedlings was tested. As no germination of the spores of *Pisolithus* could be obtained, we were compelled to get pure cultures by means of planting mycelium pieces taken out from the fruiting bodies. A better growth of *Eucalyptus* seedlings was observed in the presence of the fungus.

It was found that the mycelium, growing on various substrates, excretes some kind of a dark substance which is assumed to cause a slight decrease in the pH of the substrate. This might be important in calcareous soils, where the availability of various minerals is controlled by the pH.

In another series of preliminary trials, the capability of the fungus to transfer minerals from the medium into *Eucalyptus* tissues was tested with radioactive iodine in Erlenmeyer flasks. The mycelium was growing out of a glass jar, penetrating into the outer medium where the *Eucalyptus* cutting was placed and forming a mantle around it. The iodine, which was applied to the jar, was 6 hours later found in the *Eucalyptus* tissues, although in very minute amounts. The small amounts transferred by the fungus are thought to be due to the short time of exposure. Experiments in this direction are continued.

The above may not be the only ways of influence of the fungus on the growth of *Eucalyptus* plants, and further research on these lines is very promising.

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